NEXT MEETING, SEPTEMBER 18th, 1895.

Entered as matter of the second class at the New York, N. Y. Post Office, November 26th, 1890.

VOLUME XII.
NUMBER 5.

[COPYRIGHT, 1894.]

MAY, 1895.

Annual Subscription $5.00
Single Copies - 50

TRANSACTIONS

OF THE

AMERICAN INSTITUTE

OF

ELECTRICAL ENGINEERS.

CONTENTS.

	PAGE.
Leonard on European Engineering, Discussion in Chicago, February 27th, 1895	253
Ryan and Thompson on Armature Reaction, Discussion in Chicago, March 20th, 1895	258
Announcement of Death of Treasurer, George M. Phelps, and Report of Committee on Resolutions, April 17th, 1895	264
Assoc. Members Elected and Transferred, April 17th, 1895	266
Houston and Kennelly on Resonance, Discussion in New York, April 17th, 1895	268
Anthony on Underwriters Rules, Discussion in New York, April 17th, 1895	280
" " Chicago, " 17th, 1895	293
Annual Meeting, New York, May 21st, 1895	300
Report of Council	300
" " Secretary	302
" " Treasurer	303
Assoc. Members Elected and Transferred, May 21st, 1895	304
Preliminary Report, Committee on Indexing Electrical Literature	304
Anthony on Underwriters' Rules, Discussion in New York, May 21st, 1895	308
Tellers' Report	329
Advertisements	331

PUBLISHED MONTHLY BY THE INSTITUTE, UNDER THE SUPERVISION OF THE COMMITTEE ON PAPERS, MEETINGS AND EDITING.

RALPH W. POPE, *Secretary*,
26 CORTLANDT STREET NEW YORK CITY.
Telephone, 2199 Cortlandt.

SPECIAL NOTICE.—The bound volume for 1894 is now ready.

OFFICERS AND MEMBERS OF THE COUNCIL.

1895-96.

PRESIDENT:

DR. LOUIS DUNCAN,
Term expires 1896.

PAST-PRESIDENTS:

DR. NORVIN GREEN, 1884-5-6.
FRANKLIN L. POPE, 1886-7.
T. COMMERFORD MARTIN, 1887-8.
EDWARD WESTON, 1888-9.
PROF. ELIHU THOMSON, 1889-90.
PROF. W. A. ANTHONY, 1890-91.
ALEX. GRAHAM BELL, 1891-2.
FRANK J. SPRAGUE, 1892-93.
DR. EDWIN J. HOUSTON, 1893-4-5.

VICE-PRESIDENTS:

Terms expire 1896.
PROF. WILLIAM A. ANTHONY,
PROF. FRANCIS B. CROCKER,
JAMES HAMBLET.

Terms expire 1897.
ANGUS S. HIBBARD,
DR. MICHAEL I. PUPIN,
W. F. C. HASSON.

MANAGERS:

Terms expire 1896.
PROF. HARRIS J. RYAN,
CHARLES HEWITT
J. J. CARTY,
WILLIAM J. HAMMER.

Terms expire 1897.
A. E. KENNELLY,
WILLIAM D. WEAVER,
CHARLES S. BRADLEY,
W. B. VANSIZE.

Terms expire 1898.
CHARLES F. SCOTT,
BION J. ARNOLD,
CARL HERING,
DR. CARY T. HUTCHINSON.

Terms expire 1896.

TREASURER:
GEORGE A. HAMILTON,
22 Thames Street, New York.

SECRETARY:
RALPH W. POPE,
26 Cortlandt St., New York.

Board of Examiners:
E. T. BIRDSALL,
J. STANFORD BROWN.
C. O. MAILLOUX,
EDWARD P. THOMPSON.

Standing Committees appointed by direction of Council:

Committee on Papers, Meetings, and Editing.

FRANCIS B. CROCKER, Chairman.
J. J. CARTY, JOHN W. HOWELL, DR. M. I. PUPIN, GEO. M. PHELPS.
PROF. H. J. RYAN, DR. SCHUYLER S. WHEELER.

Sub-Committee on Editing.
GEORGE A. HAMILTON, Chairman.
C. O. MAILLOUX,
FRANKLIN L. POPE.

Sub-Committee on Papers and Meetings.
T. COMMERFORD MARTIN, Chairman.
HORATIO A. FOSTER,
H. WARD LEONARD,
WM. MAVER, JR.,
HERBERT LAWS WEBB.

Library Committee.

J. STANFORD BROWN, Chairman.
GEORGES D'INFREVILLE, GEORGE H. STOCKBRIDGE.

Committee on Finance, Building and Permanent Quarters.

GEORGE M. PHELPS, Chairman.
GEORGE A. HAMILTON, DR. SCHUYLER S. WHEELER, THOMAS A. EDISON,
FRANKLIN L. POPE, FRANCIS R. UPTON, T. COMMERFORD MARTIN,
DR. F. BENEDICT HERZOG.

Committee on Units and Standards.

A. E. KENNELLY, Chairman. GEO. A. HAMILTON, DR. WM. E. GEYER,
FRANCIS B. CROCKER. WILLIAM D. WEAVER.

Committee on Membership etc.,

RALPH W. POPE, Chairman
THOMAS D. LOCKWOOD, Local Secretary, Boston, Mass.,
DR. LOUIS DUNCAN, " " Baltimore, Md.,
CARL HERING, " " Philadelphia, Pa.,
PROF. EDWARD L. NICHOLS, " " Ithaca, N. Y.,
JOSEPH WETZLER, R. N. BAYLIS, H. A. FOSTER, New York City.

BION J. ARNOLD, Local Honorary Secretary,
1141 Marquette Building, Chicago Ill. Telephone, Main 4074.

Discussion in Chicago.

The Western members of the Institute held a meeting in Armour Institute on Wednesday evening, February 27th, the same evening as the New York meeting. Mr. B. J. Arnold, the Local Honorary Secretary, called the meeting to order, about forty-five members and visitors being in attendance. Upon motion, Mr. C. K. McFadden was appointed Chairman. The paper of the evening, "Notes on Recent Electrical Engineering Development in France and England," by Mr. H. Ward Leonard, was read in detail by Mr. A. V. Abbott, after which it was discussed at length as follows:—

Mr. B. J. Arnold:—One point made by the paper is with reference to the adoption of higher secondary voltages abroad. This is something which we are bound to come to in this country, and a large number of station managers are even now adopting 100 volts on secondaries. For my part, I can see no reason why it should not be done, but I think that the cause of its not being looked upon favorably in the past, is that people were unable to obtain suitable lamps.

On the Subject of the Steam Turbine.—I was very much interested in the Laval steam turbine at the World's Fair. I was in its vicinity quite often, and I must say that the economy realized by these engines is something remarkable, when we consider that they are rotary engines in reality. They do, however, utilize the force of steam quite expansively and to an extent which few other rotary engines do. I understand from an engineer who had seen these machines in operation in Europe that one of the difficulties encountered when running at this enormously high speed is to cause the disk to thin out near the shaft or expand from the shaft. There is only one remedy for this, and that is to run slower, which, of course, will reduce the efficiency. At a speed of about 30,000 revolutions per minute, the metal begins to expand, the rim gets larger and larger, and when the wheel stops, it is of greater diameter than when it first started.

On the Subject of Batteries.—From the records I have of European stations, I find that the average commercial efficiency is about 76 per cent. (The author gives 60 per cent.) His statement is high enough at the high rate of discharge which he gives, but batteries should be, and usually are, operated at a lower rate of discharge. When operated properly at a discharge of 10 per cent. of their capacity, the average commercial efficiency is about 76 per cent. The highest may run up to 78 per cent., and the lowest to 73 per cent. The greatest difficulty that we have in this country with batteries arises from two causes; the first is in the commercial desire to place something on the market for as little money as possible. The result is that there have been a number of plants installed throughout the United States, which have been too small for the work required of them. The batte-

ries were unable to stand up under the work and went to pieces in a short time. Battery plants have been installed in this country under conditions where they never should have been, with the expectation of saving something, viz.: in cases where the work has been too great, and where engines and dynamos should have been installed instead. Where the average load throughout the twenty-four hours is large, it is useless to install batteries, except as regulators for railway stations, where they will show economy; but where the load is at its maximum for a few hours each day, as it is in apartment houses, and light for the larger part of the time, they will show a decided gain in operating expenses, if properly installed and operated, as the entire labor is eliminated from the plant for over half the time.

Some months ago, when the Heilmann locomotive made its appearance, I expressed a very decided opinion against the general plan of the machine and what was claimed for it. I have watched its record as closely as possible from the technical press, and fail as yet to see good reasons for changing my views regarding it. The only possible advantages it seems to me to have, are the ability of applying a continuous rotating effect or torque to the drivers, and the abolition of counterbalancing, which is destructive on roadbed and track. It has all the disadvantages of the ordinary locomotive, so far as cleanliness is concerned, and is still further handicapped by its excessive cost and extra expense for men in operating it. I think its chief function will be as an entering wedge for the adoption of electric traction on steam roads, or rather as a go-between between the steam locomotive and the electric motor driven from a central station.

PROF. W. M. STINE:—The paper covers so much ground that one is almost at a loss to attempt a discussion of it. There are a good many things that can be said with reference to what the author calls the storage battery issue. I quite agree with the remarks made by Mr. Arnold. I have seen figures given in the London *Electrician* within the last month, giving energy efficiency, not ampere efficiency. In Europe, where they seem to be making most use of the storage battery at present, the conditions under which it is operated are very different from this country, and on this basis alone it is questionable whether we would be justified in imitating foreign practice. It can perhaps be shown that a storage battery plant, when well taken care of, will prove satisfactory and economical. This subject was pretty thoroughly discussed at the Cleveland meeting last week, and there were some very surprising figures given. I think, however, that the average central station manager in this country is not very enthusiastic over the storage battery.

Analyzing the weight of a locomotive, we may divide it into three factors. The one factor is that of the supply weight, and the weight of the tender itself. The next factor is the dead weight on the pony wheels, and the third factor is the tractive

weight on the driving wheels. If we average the tractive weight of the ordinary express locomotive, the dead weight reaches the large value of 40%. We may accept this as the real condition of affairs, but the 40% dead weight is what to a great extent is causing the present railway financial condition. Much of the increase in the cost of construction and maintenance of the railways seems to be necessitated by the useless weight carried by the engine. It is not the train so much as it is the dead weight of the locomotive which is responsible for these things. If electricity is ever going to accomplish anything at all, it must be in lessening this 40% dead weight. The question of the Heilmann locomotive is whether it can be reduced to the necessary tractive weight. I think that the total tractive weight is not excessive for the speed the locomotive can attain. This question was raised the other day by a railroad man, and for this reason I have made an analysis of the Heilmann locomotive.

MR. C. K. MACFADDEN:—That part of the paper referring to the Heilmann locomotive was the most interesting section to me. I have made a number of tests on passenger locomotives on one of our largest western roads, and I was prepared to find some very peculiar results when I started in on that work. My experience I must confess was very surprising, when in taking my first indicator cards from a modern ten-wheel engine, I found them to very closely resemble cards taken from an automatic high-speed electric light engine, whose valves were in first-class condition. The boiler had about 1,400 square feet of heating surface, and I have taken cards from the engine it supplied up to 1,000 H. P. This locomotive was one on which it was impossible to make the wheels slip, even with a full boiler pressure, which varied from 160 to 170 pounds. The speeds ran as high as 70 miles per hour and over, and all tests made were on locomotives running in the regular fast passenger service. The engine was a new one weighing 90 tons, and the total weight of train was 450 tons. I have here a few cards taken in this test. The first card shows the action of the valve motion when the point of cut-off is being altered. The second shows the steam distribution when the engine is developing 540 H. P. at 26 miles per hour; the third card shows the engine running at a high speed, 66 miles per hour, developing 904 H. P.; the fourth shows it running at 42 miles per hour, 641 H. P., and the fifth shows it at 36 miles per hour, 720 H. P.

I will say that I quite agree with Mr. Arnold in regard to the Heilmann locomotive. I can hardly see where the immense economy can be attained by using such a system. The first thing to be considered is the original cost. The cost is given as $30,000, and, though this is but a single locomotive, the chances are that it would cost $25,000 in lots of ten. A locomotive can be bought for $8,500 to $8,700, of the size spoken of, on which tests were made by me. It will develop 600 H. P. continously. The wages

of a competent road engineer are undoubtedly much higher than that of a stationary engineer, and the wages of the help required on the Heilmann locomotive would certainly be even greater than on a common locomotive. Of course we know that it is useless to expect the steam railroad to incur the enormous expense necessary to give electric traction a trial, unless there is no doubt of its making a large saving over steam. When the Heilmann locomotive is given a thorough trial, the test of electrical traction will have been at an expense of only $30,000. I think the electric locomotive has much to commend it for high speed service, but I do not think that it will come into common use in the form shown in the French engine. I think that as a motor at the front of a train it will have its greatest value. There is no doubt that a train can be pulled by an electric locomotive. This is certainly possible, but this is not the question. The question is, whether or not a railway president can say to his stockholders: "I can make a net saving in operating expenses by adopting electric locomotives over the best I can do with steam."

MR. SUMMERS:—What about the back pressure?

MR. MACFADDEN:—I made a number of tests on this subject, and found that the back pressure varied largely with the engineer, although, of course, the exhaust nozzles retard the steam to some extent. Intelligent work on exhaust nozzles has greatly reduced back pressure, and the back pressure shown on a few cards will explain my meaning, all of the figures being taken from the same engine the same day:

560	H. P.,	18	miles per hour.	Maximum back pressure,		28	lbs.
900	"	66	"	"	"	15	"
720	"	36	"	"	"	13	"

I tried letting the lever down to the last notch when running at 30 miles per hour, and found that the back pressure ran up to 56 lbs. The thermal storage in a locomotive boiler comes into play in a very remarkable way. A boiler can supply for a limited time 1,000 or 1,100 H. P., but will not supply more than 600 H. P. continuously. I found that in hauling this particular train, which was a very fast one, the amount of fuel used was very reasonable. A ton of cheap coal will carry a train of this kind 28 miles, the locomotive making possibly 4,500 miles in a month, which is twice the distance traveled by the Heilmann locomotive as yet. A pound of coal is equivalent to 5.1 ton miles. On another series of tests which we made, we found that we averaged for a week 8.2 lbs. of water per pound of coal. This coal was a good grade of Pittsburg coal. The average on some 1,000 different locomotives was found to be from 5 to 6 lbs. of water per pound of coal, the fuel being cheap Illinois bituminous coal. As I say, this engine was handled in a proper way. The valves were balanced, so that it was a comparatively easy matter to manage the valve motion. I simply give this as an example of such an engine, as used to a great extent on a number of our largest roads.

I would say in conclusion, that the average locomotive is hardly a fit standard from which to judge the saving to be effected by the use of electricity. There is often a great difference in different engineers, sometimes 30 per cent. being the saving effected by one engineer over another on the same train and engine. Three months' work among the engineers of a prominent western railroad by its superintendent of motive power has already effected a saving which will pay 6 per cent. interest on nearly two millions of dollars, and he thinks his work has hardly commenced.

MR. A. V. ABBOTT:—I was called upon, some years ago, to design a plant for electric lighting, in which the circuit spread over a considerable territory. The station was operated by water power, the cost per annum being $5 per H. P., so that the expense of the power was comparatively small. The town was laid out in a series of blocks extending in three parallel lines away from the station. The design of the plant involved operating at 3,000 volts alternating, running a series of feeders from the station. The center of distribution was located as nearly as possible at the electrical center of gravity of the leading section of the town. The transformers, instead of being placed in each house, were arranged on the diagonally opposite corners of each block, and the secondary mains were arranged upon the three-wire system. By this means, with the use of a comparatively small amount of power in the secondaries, the transformer load was steadied to a great extent, a notable saving in the number of transformers and connections being accomplished; and the experiments showed that the transformers were operated at about 80 per cent. of their calculated load.

Discussion in Chicago.

A meeting of the Western members of the Institute was held in the Physics Lecture Room of Armour Institute, March 20th, on the same evening as the New York meeting. The Local Secretary, Mr. B. J. Arnold, called the meeting to order, about sixty-five members and visitors being in attendance. Upon motion, Mr. S. A. Rhodes was appointed Chairman. The paper of the evening—"A Method for preventing Armature Reaction" by Messrs. Harris J. Ryan and Milton E. Thompson, was read in detail by Professor S. B. Fortenbaugh of the University of Wisconsin, at the authors' request.

Mr. B. J. Arnold:—I feel that this subject is something out of the line of work upon which I am posted, although I realize the importance of accomplishing the object the author has outlined. The chief objections to the kind of electrical machinery which engineers have had to use in the past have been the high rotative speed, and the difficulty of preventing the commutator from sparking under great changes of load. The main reason for using high speeds has been to enable the manufacturer to produce machines of large output at a cost within the reach of the purchasers. We are now, however, rapidly coming to regard slow running direct coupled generators as standard, and the competition among manufacturers, owing to the expiration of patents and the entering of new firms into the field has resulted in decreasing the price of dynamo-electrical machinery to a point which makes large, slow running machines available, at a cost not much in excess of belted machines. The question of no sparking at various loads seems to me to have already been well met by the manufacturers, as, under specifications issued recently, and upon which four leading manufacturers bid, all guaranteed that their machines would not spark at all from no load to 50 per cent. overload. If they accomplish this, and it seems that some of them do by correct dynamo design, without the use of auxiliary coils, I see no reason for the introduction of them, as the author suggests, as it must necessarily increase the cost of the machine. I have no doubt, however, that the coils introduced as he plans them, will prevent an otherwise badly designed dynamo from sparking. The manner, however, in which the author has undertaken to prevent armature reaction is at least heroic, and reminds me of the manner in which Professor Thomson some years ago succeeded in preventing an otherwise destructive effect on his arc-lighting machine, viz:—the excessive spark across the air-gap on his three part commutator, by introducing an air pump or blower to blow out the spark. This method was successfully introduced, and is in use on thousands of dynamos throughout this country to-day, although it now seems advisable to design arc light dynamos which do not produce sparking at the commutator at all, and therefore have no necessity for air blasts or other means for the external prevention of sparking.

MR. A. V. ABBOTT:—There is no doubt at all but that Professor Ryan's method could be successfully applied, and he seems to have hit upon an invention which has been greatly needed. From a mechanical standpoint, dynamo constructors have endeavored to attain these conditions. This form of construction was taken up some five or six years ago, but for some reason was dropped. It was attempted to employ balance coils somewhat in the way Professor Ryan does, but the difficulty was in the winding of the coils about the field magnets. At the time I refer to, the amatures were smooth bodied. Armatures with slots of the Pacinotti type were considered to be of practically no value, and it was only by the application of a slotted core that balance coils operated successfully.

PROF. W. M. STINE:—I scarcely feel like discussing the paper, for as it stands it is so clearly written and the results are so evident that there seems to be very little ground left for discussion. However, it appears that under best conditions, it will no doubt prove very successful, but I am inclined to think that the boundary between success and failure is very narrow. I think that if the correcting winding is not very accurately placed, it will have a reverse effect as the author clearly indicates. I am inclined to think that this is a point that will cause quite a little difficulty at first. The exact balancing of the coils; putting the ring on the field properly may lead to some serious failures at first. It may be that the machines will be so thoroughly built that these difficulties will be obviated.

I am surprised that the author makes no mention of the work of Sayers in England. I would say that the work of Sayers is to put reactive coils on the armature instead of on the fields. This device is built and is on the market in active operation. I notice that a paper has recently been read before the Institution of Electrical Engineers in London in which Sayers gives data of two years' test of this device. I am unusually interested in this device of Prof. Ryan's in placing it alongside that of Sayers.

MR. C. E. KAMMEYER:—I would like to ask whether or not the experimental machines referred to have ever been run at their rated output for any length of time. I think that machines of this type or any type should be able to run 24 hours continuously at full load if necessary, without seriously heating, and I am very much interested to know if such tests have ever been made on these machines.

PROFESSOR FORTENBAUGH:—Regarding the question as to whether there has been any test made to this extent I can say this, that I do know of this first machine having been run for 10 or 12 hours at a time, but not for 24. No mention is made of the rise of temperature after having run for two or three hours. In a large machine it will take at least 5 or 6 hours before it becomes thoroughly heated.

Mr. L. L. Summers:—I believe that some of the companies have adopted a standard of four or five hours for a test run. My information comes from one of their testing experts, who has tested some of the largest of their machines. I think that for practical purposes a run of four or five hours will usually be sufficient for the machines to attain their highest temperature. I think that the question of armature reaction is of great importance in machines for special work. I had occasion to change the secondary winding of a dynamotor for the purpose of lowering the voltage, and upon figuring out the cross magnetization I came to the conclusion that I could decrease the length of the primary winding about 16 per cent, and instead of its increasing the speed of the machine as one would suppose it would, the speed would remain constant, showing the effect of armature reaction may have in this class of machinery.

Professor Fortenbaugh:—The paper written by Professor Ryan seems to be a presentation of results rather than a sketch of the possibilities of the device, and from these results I think no other conclusion can be drawn, than that it is a practical success. Now, can it be built satisfactorily and cheaply? These balancing coils are now made so that they can be put on with no injury to themselves or to the machine under ordinary conditions, and the effect that these coils have on the armature reaction more than compensates for any complications that may arise by their use. There seems to be some doubt as to whether or not they increase the cost of the machine. Professor Ryan assures us that the increased cost, due to the coils, is more than counterbalanced by the saving of materials, and therefore I do not see why it should not be a commercial success.

I wrote Professor Ryan, asking him about the increased cost, and though I have received a letter from him since, he has said nothing about this, and I took it for granted that he thought the question sufficiently answered in the last paragraph of the paper. And furthermore if there is any slight increase in the cost of manufacturing this machine, we know that the efficiency at all loads is very much increased, and therefore we have a continual saving in this way which more than covers the extra expense of constructing it.

Professor W. M. Stine:—I would like to ask whether the external compound or series coils were effected on the Thomson-Houston machines?

Mr. B. J. Arnold:—We always regarded the compound winding as a very essential part of the machine.

Mr. A. V. Abbott:—I have never had the time, I regret to say, to make an actual test of this class of machines, but in a southern station where we had three Edison '80 H. P. machines, and two Thomson-Houston machines, so far as actual running conditions on the railway were concerned, we could run the Thomson-Houston without moving the brushes at all, where we

could not do so with the Edison. When all the Edison machines were running at full load, for some reason or other the load might be suddenly thrown off and they would spark considerably, so that the attendant would be compelled to keep his eye on the commutators, whereas with the Thomson Houston machines there is no need of doing anything to the brushes at all.

MR. KAMMEYER:—While the authors seem to have solved the problem of preventing armature reaction, and thereby doing away with sparking at the brushes, I do not believe they have given due credit to other dynamo builders. I fully believe that machines are being built to-day without balancing coils that will not spark when running at full load or even at overload, and that do not require the shifting of brushes under varying loads. As to the higher efficiency at small loads, that I believe is a very important point, but I doubt very much that the increased cost of building machines of this kind will be compensated for by the slight increase in output. I do not believe that crowding too much machinery into a small space is a good thing. I believe in having plenty of room in your machine, and it will then run much cooler, other conditions being equal. I believe that the authors refer to one case where they have tried to get too much out of the machine. This caused me to ask how long any of these machines had been run, and I believe that if they had run them for ten or twelve hours at a time under full load, they would have found that the heat increased very rapidly.

MR. COCHRANE:—I would like to ask if the balancing coils are wound in place by hand or not. It seems to me that if they are wound by hand, the cost would be somewhat excessive.

PROFESSOR FORTENBAUGH:—These balancing coils are wound in place by hand. You seem to have the impression that this machine, when fitted with these coils, costs more than a machine constructed in the ordinary way, and the authors state that it does not. Regarding the originality or the credit for this device being given to Professor Ryan, I would say that Professor Ryan and Mr. Thompson do not claim that their idea is an original one. If you will refer to the London *Electrician* (vol. xxxi) you will find a device that is suggested by Fischer-Hinnen, quite similar to the one used by the authors. Mr. Sayers' device, with a number of others, has also been tried with apparent success. The ordinary machine, as now built, will admit of working perfectly satisfactory from no load to full load, but I know that this device of Professor Ryan's will give better satisfaction at overload, and it will more than double its load without any appreciable sparking.

PROF. STINE:—At the time this was being developed, the Thomson-Houston type of machine was pretty thoroughly tested at Cornell, and I should be very glad to hear of the experience and experiments and whether they found the reaction winding efficient, and controlled the sparking, also whether they ever

attempted to short-circuit that or whether they left it on open circuit.

Mr. O. S. Lyford, Jr.:—I happened to be at Cornell at the time when this first machine was designed, and in fact, made the drawings under Professor Ryan's direction. Since then I have kept track of the subject as much as possible, and in connection with my work have made a number of interesting observations. There are a number of machines on the market to-day which will work under all conditions of load with practically no sparking. The only advantage of this construction proposed by Professor Ryan is that it preserves the point of commutation, but there are other ways of accomplishing the same results with equal success, and I think with equal efficiency. My experience has been principally with the internal pole type of machine, and I have seen machines of this type working from no load to 50 per cent. overload without sparking, without shifting the line of commutation, and with the use of copper brushes. One of the last things Professor Ryan says in the paper is that "The M. M. F. of the armature ampere-turns may never exceed the M. M. F. impressed by the field between the pole faces." Professor S. P. Thompson's statement in reference to the same subject is that the ampere-turns of the armature circuit can not be greater than the ampere-turns necessary to produce the field in the air spaces. Contrary to either statement I have found in some instances that the armature ampere-turns may be double the field turns necessary for the air-gap. This may be due to the additional effect of the compound winding. The only thing about this proposed construction, as I have said before, is that it places the remedy at the exact point where the trouble exists. Perhaps one particular use for this construction will be where it is required to have machines work with full load but with widely varying speed. In some of the curves he shows that the voltage can be varied from 112 to 48 by varying the strength of the field, and yet the commutation remain practically sparkless. In the same manner it should be possible to vary the speed with constant voltage. This is a thing that is impossible with the old construction of machines. The possible variation ordinarily is 25 per cent. where he makes it 50 per cent. or more. This should make this style of machine well adapted for motors operating machine tools.

Mr. Ludwig Gutmann:—I believe, that Professor Ryan has taken a stand which he can easily defend. One of the speakers said that any of the present manufacturers can conform to the specifications, viz., to furnish a dynamo to operate sparkless from no load to full load, or even overload. If this method of Professor Ryan was adopted, the air-space could be considerably reduced and the capacity of the dynamo increased. It is certainly true that most manufacturers can furnish dynamos which will run sparkless over the normal range at the expense of a good deal of power and material, but I believe Professors Ryan's

method admits of better utilization of the material put into the machine and with less internal waste. By his method the present machines can be increased in output, or new machines may be built smaller for the same output and with less amount of iron and copper.

[Conclusion Communicated by Prof. H. J. Ryan.]

The 30 K. W. machine, cited by Dr. Hutchinson, is a Sprague-Pratt elevator motor, and one might as well try to discuss modern constant pressure direct current power generators by telling what one finds to be the performance, weights, etc., of the latest and best street car motors, as to cite the above excellent elevator motor. The same applies to the comparisons made by Mr. Bliss.

Mr. Kennelly has well stated what the experience of ourselves and others has been regarding the heating limit of an armature as determined by ventilation and that one finds when the ventilation is improved without sacrifice, the sparking limit may come within the heating limit.

Mr. Thompson has produced an armature design that affords ventilation of the conductors proportional to their number or depth on a given core. The output figures, 20 to 30 watts per pound, were based on the results of experiments made with a machine designed and built by Mr. Thompson and tested about the time when this paper was written. It was not described in the paper because it was not our object to discuss armature ventilation at this time.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

New York, April 17th, 1895.

The 96th meeting of the INSTITUTE was held at 12 West Thirty-first Street this date, and was called to order by President Houston, at 8.15 P. M. Seventy members and guests were present.

THE PRESIDENT:—Gentlemen, before proceeding with the regular course of business, it is my sad duty, as President of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, to announce to you the sudden death of our Treasurer, Mr. George M. Phelps. There were few, if, indeed, any, of the members of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS who were more closely identified with the growth and work of this institution than Mr. Phelps. He was one of our charter members. He was elected a manager in 1885, and had, since that time, been continuously a member of Council. He was elected Treasurer of the INSTITUTE in May, 1887, and had held that office continuously until the time of his death. These facts, are in themselves, evidences of the very high esteem in which our late Treasurer was held by the INSTITUTE. My acquaintance with Mr. Phelps commenced with the beginning of our INSTITUTE in 1884. I was first brought into contact with him at the International Electrical Exhibition, held in Philadelphia, under the auspices of the Franklin Institute. I learned then to respect the gentleman for his many good qualities. While I have not had that intimate friendship and acquaintance with him, which some of you have had, yet I wish to testify to the many excellent traits of character he possessed, especially to the excellent and faithful services he has rendered me, as your presiding officer, during the two years in which I have had the honor to be connected with the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS as its president.

Genius is a rare gift, and if it be true that genius consists in the possession by one individual of some trait of character, not possessed in general by mankind, then I take it that the faculty called common sense is one of the most marked attributes

of genius since it is so very uncommon. Our late Treasurer, in my judgment, possessed an uncommon amount of that very uncommon trait, common sense. This was particularly noted in the council chamber, where we were always sure, if a knotty question arose, that needed a clear understanding and calm judgment, that we would get the best of advice from our late Treasurer.

I join with you in mourning over his sudden death. Death is at best an unwelcome visitor. But nature is merciful to us at least in this respect, that when death comes with old age, she kindly tempers our departure so that when we die, we practically have been dying for many years. But when a man is struck down in the vigor of his manhood, right at the height of his usefulness, as was our late Treasurer, then death indeed becomes a sad visitor.

I will not attempt to speak of the social characteristics of Mr. Phelps or of those traits which so distinguished him as a man; for, as I have said, you know them well. He was a dignified gentleman, and if we add, of the old school, it is certainly not to his detriment. He was a delightful companion, a sympathetic friend, a faithful brother, a loving father and husband, and I think that it can be said of him that he filled the measure of a useful life, in that he so lived that the world was better and brighter and happier that he had lived in it.

I felt that it would not be proper for me to open the meeting of the INSTITUTE without making some brief reference to the death of our Treasurer, and I trust that you will pardon the very imperfect manner in which I have made it.

MR. HAMMER:—In connection with this announcement permit me to read the following communication from the Council:

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

New York, April 17th, 1895.

The Council of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, desiring to express its sense of the loss to the INSTITUTE in the death of George May Phelps; at its meeting held Wednesday afternoon, April 17th 1895, at the INSTITUTE headquarters appointed a special committee of three to draft suitable resolutions which the undersigned as committee herewith respectfully present.

Resolved: That in the death of George May Phelps, the Council has suffered the loss of an energetic, faithful and capable member, and the INSTITUTE a most efficient officer; one who was constantly striving to uphold the standard of its work, and one who was ever watchful of its welfare. In his disinterested efforts to serve the INSTITUTE, he brought to bear upon its deliberations, his keen perceptions, intellectual ability, and eminent force of character.

Resolved: That a copy of this resolution be suitably engrossed and framed, and presented to Mrs. George Wallace Graham, his daughter, and the sole surviving member of his family.

(Signed) WILLIAM J. HAMMER.
JAMES HAMBLET.
RALPH W. POPE.

MR. A. E. KENNELLY:—Mr. President, I beg to move that the INSTITUTE hereby cordially and unanimously adopts the resolution which has been placed before it.

PROF. ANTHONY:—Mr. President, I second that motion.

THE PRESIDENT:—It is moved and seconded as you have heard. Those in favor of the motion, will signify their assent by rising.

[The motion was unanimously carried.]

THE PRESIDENT:—The Secretary will now read the minutes of the last meeting.

The Secretary read the minutes of the ninety-fifth meeting of the INSTITUTE held March 20th, 1895, which were approved.

THE SECRETARY:—At the Council meeting held this afternoon the following associate members were elected:

Name.	Address.	Endorsed by
BALDWIN, JAS. C. T.	Superintendent Chicago Telephone Co., 203 Washington St.; residence, 1350 Washington Boulevard, Chicago, Ill.	A. V. Abbott. S. J. Larned. A. S. Hibbard.
CABOT, FRANCIS ELLIOTT	Supt. of Inspection and Electrician, Boston Board of Fire Underwriters, 55 Kilby St.; residence, East Milton, Mass.	E. J. Houston. W. J. Jenks. A. E. Kennelly.
FORTENBAUGH, S. B.	Asst. Prof. of Electrical Engineering, University of Wisconsin, Madison, Wis.	D. C. Jackson. F. R. Jones. Harris J. Ryan.
HARRIS, W. C., JR.	Electrician, Harris & Williamson, Birmingham, Ala.	Geo. H. Harris. R. S. Gross. Richard Varley, Jr.
JONES, G. H.	Agent, General Electric Co., Casilla 18 D Santiago; residence, Iquiqui, Chili.	J. W. Kirkland. John B. Blood. Chas. P. Steinmetz.
LEBLANC, CHARLES	Chief Engineer Railway Department, Thomson-Houston Co., 27 Rue de Londres, Paris, France.	F. J. Sprague. S. D. Greene. D. C. Jackson.
LINDSAY, WM. E.	Chief Engineer and Electrician, Swift & Co., National Stock Yards, East St. Louis, Ill.	Fred'k Bedell. Ernest Merritt. Harris J. Ryan.
NUNN, PAUL N.	Consulting Engineer, San Miguel Cons. Gold Mining Co., Telluride, Colo.	C. P. Steinmetz. A. Jay Wurts. Chas. S. Bradley.
WINSLOW, GEORGE HERBERT	Electrical Engineer, Westinghouse Elec. & Mfg. Co, Pittsburg, Pa.	A. Jay Wurts. L. B. Stillwell. Chas. F. Scott.

Total, 9.

The following associate members were transferred to full membership, their applications having been approved by the Board of Examiners, March 12th, 1895.

SCHMID, ALBERT	Superintendent, Westinghouse Electric and Mfg. Co., Pittsburg, Pa.
DODGE, OMENZO G.	Professor of Mathematics, United States Navy, Washington, D. C.
CARUS-WILSON, CHARLES ASHLEY	Professor of Electrical Engineering, McGill University, Montreal, Can.
LIGHTHIPE, JAMES A.	District Engineer, General Electric Co., San Francisco, Cal.

CHILDS, ARTHUR EDWARD	Electrical Engineer, Westinghouse Electric and Mfg. Co., Philadelphia, Pa.
WARING, JOHN	Warner Electric Co., Ovid, N. Y.
PUFFER, W. L.	Assistant Professor of Electrical Engineering, Mass. Institute of Technology, Boston, Mass.
RYAN, H. J.	Professor of Electrical Engineering, Cornell University, Ithaca, N. Y,

Total, 8.

At the same meeting Mr. George A. Hamilton was elected Treasurer to serve for the unexpired term of the late Treasurer, George M. Phelps.

THE PRESIDENT:—The first business of the meeting is the reading of the paper by Mr. Kennelly and myself on "Resonance in Alternating Current Lines." Will Mr. Kennelly read the paper?

[The paper was read by Mr. Kennelly. See page 203, April TRANSACTIONS.]

Discussion.

The President:—This paper is now open for discussion.

Mr. Charles S. Bradley:—Mr. President, this paper is a little in advance of my mathematics. I do not mean to cast any reflection upon Mr. Kennelly at all. It is often said that the papers are too mathematical. I do not think that is true in this case; I did not mean to insinuate that it was. It is made as plain, I think, as any such matter can be made, and I think great credit is due to you both for bringing out such a paper as this; for most people want to conceal and keep back for their own use all of these very valuable considerations. This is going to prove of great value to the alternating current work, I have no doubt; I am very certain of it. Although I cannot fully follow it, I can follow a portion of it, and I must say it is very instructive. The wave is a very striking thing, indeed, and I can say nothing except to praise the paper. I am unable to criticise it.

Dr. M. I. Pupin:—I venture to offer one or two remarks only on the paper. I think that it is a very useful thing to have certain mathematical functions, with which we are not very well acquainted, worked out numerically, and, if possible, reduced to graphical representation. This is especially true of the so-called hyperbolic sine and the cosine. These are the functions which puzzle us considerably in the problem of transmission of current along a line possessing appreciable distributed capacity, self-induction and resistance. The problem is an old problem, and used to engage the attention of some of the ablest physicists. As far as I know, the earliest authority on this problem is Prof. Kirchhoff, the same man who discovered spectrum analysis. He attacked the problem in 1857, and gave us what may be considered a complete solution of it. This paper of Prof. Kirchhoff is memorable for several reasons, and especially because in this paper it was stated for the first time in the history of electricity, so far as I know, that under certain conditions the velocity of propagation of an electric wave along a conducting wire is equal to the velocity of light. The result was predicted on the basis of the old theory.

The other reason why this paper is especially memorable is this: Prof. Kirchhoff attacked the problem as a physicist would do; namely, he considered in the first place a system in which there are a certain number of forces acting. Then he considered the physical constants of the system, and looked then for the fundamental relation between these forces and these constants. This is, in fact, the method which is general to all the physical problems, whether electrical, mechanical or any other kind. The fundamental relation which he obtained between the impressed electromotive forces and the physical constants of the line, that is self-induction, capacity and the resistance per unit length, is strikingly the same as the funda-

mental relations which exist between the impressed forces on a flexible, suspended string and the physical constants of that string—namely, the weight per unit length, the tension, internal resistance, air resistance, etc. If the fundamental relation is the same in the two cases, it follows that the vibration of the string will follow exactly the same law as the transmission of an electric wave along the conductor, exactly the same; knowing one, we know the other. That is what I should call reasoning by analogy. It is not an analogy suggested by superficial observation, but it is an exact analogy. The employment of such analogies in our reasoning has been criticised lately on several occasions by people who ought to know better. Now, if we consider the motion of a string, we will get most of the results which the President and Mr. Kennelly have indicated in their very carefully worked out paper. We shall have what they choose to call resonance, when the energy which is communicated to the line reaches the end which is insulated, and is reflected, and the reflected wave and the incoming wave interfere and form stationary waves; and in a particular case, that is a case where we have no damping, of course, the returning wave would be almost as strong as the incoming wave, and we would have maxima and minima. The minima would be almost equal to zero. In this case they are not, because there is damping. Of course, it makes a difference whether the line is perfectly insulated or not. The damping factor, is the factor which consumes the energy of the wave. It is especially the ohmic resistance. The velocity of the wave, of course, as we all know, depends on the period of the wave. It is not the same for all periods. The wave is faster, the shorter its time of vibration; and the longer the time of vibration, the slower and the longer it is, and so on.

Now, Prof. Houston and Prof. Kennelly seem to be alarmed by the fact that certain people have made the very unscientific remark that transmission of energy can be effected more economically and better by a resonant line than by a line which is not resonant. That sounds to me like wanting to eat a cake and have it. The very fact that you have resonance means that you are accumulating something, that you are putting power upon a line without utilizing it. If you utilize it, of course then there is no cumulative effect, and there is no resonance. Mr. Kennelly has expressed that very well by saying that the resonance effects depend very much on the elastic reflection of the terminus of the line. Now in a great many cases we really do not care to transmit power in the ordinary sense of the word—that is, a large amount of power, over a long line. In these cases resonance, whether in this shape or in any other shape, offers considerable prospects. For instance, if we wish to transmit power to a certain point—a small amount of power—and we do not care what the efficiency of the transmission is, for in-

stance, in telegraphy or telephony, we really do not care how much we put in—within certain limits, of course—provided we can get enough at the receiving end. This is a point worthy of our consideration, and I was rather disappointed when I saw that Professors Houston and Kennelly did not discuss this problem more fully than they did. But still, along the lines indicated by them, I think the subject could be very easily continued.

I think Professors Houston and Kennelly deserve great credit for the extremely careful way in which they have worked out the figure of Plate I, and I am glad to hear that anyone who wishes to have this plate can have it in enlarged form, because it really simplifies numerical calculations very much.

Mr. President, I take the pleasure of introducing to the INSTITUTE one of our fellow members, Dr. Webster of Clark University, who takes great interest in the INSTITUTE. I have no doubt that the members of the INSTITUTE would be pleased to hear what Dr. Webster has to say on the subject of this evening, especially since he is interested in a line of work which is within the region of our present discussion.

THE PRESIDENT:—I am sure we should all be pleased to hear from Dr. Webster.

DR. ARTHUR G. WEBSTER:—Mr. President and gentlemen of the INSTITUTE, I hardly expected to be called upon to address you on this my first appearance in this honorable body, in which, as my friend Dr. Pupin says, I take great interest, although I live somewhat out of the radius of New York.

I am extremely interested in this subject. I have thought about it for a good many years, and I have listened with great admiration to the reading of the paper, which I was fortunate enough to be able to look over before coming here. Some of my preconceived ideas have received a considerable shock in the course of that reading. Not being an engineer myself, and not knowing engineers as well as I wish I did, I had supposed that an engineer was an extremely busy man and that he was mostly occupied in doing practical things which brought him in a certain amount of very pleasant returns which are not open to people in my own position. But I came to the conclusion that there are engineers who delight in doing other things, who are willing to do work in arithmetic, which I may say for myself I find a terrible grind. If I have been fortunate enough to get certain experimental results and put them down in my note book, when it comes to working the calculations over, I should prefer to send them several hundred miles rather than do it myself. But I have come to the conclusion that business is probably a little slack in Philadelphia. I have always had the impression that there were more hours in the day in Philadelphia than in New York. But I see that there must be a good many more hours in the day, and a good many more days in the week, and if I might take the liberty I should be glad to ask Mr. Ken-

nelly privately how long it took him to draw that diagram. I was extremely interested in that part. I may say, in the first place that not having brought a dictionary with me I was a little at a loss for some of these terms ending in "ance," and if Mr. Kennelly's forbearance is as great as his admittance I will proceed to make a few remarks which I hope may be pertinent to the question. As I have said, it is extremely pleasant to find somebody who is willing to work out results which we may have had in formulas and to give us arithmetical results, with curves and pictures which it is pleasant to see and also to own. I am going to make a suggestion to Mr. Kennelly, which will entirely change the appearance of that plate, if he adopts it, although I do not expect he will, as the plate is engraved. As Dr. Pupin has said, this question is one of the most interesting in this department of mathematical physics, and has been so ever since it was taken up so long ago by Kirchhoff. All the results arrived at here to-night are probably in that paper. But it is very pleasant to think that when some eight or nine years ago I began reading the works of Mr. Oliver Heaviside, published in the London *Electrician*, before the advent of the omniscience which now rules in that quarter, I found that Mr. Heaviside had taken up the same problem and had come to the same results all by himself, and when he got all through he found that Prof. Kirchhoff had done the same thing twenty years before. That illustrates a disease peculiar to Englishmen, and others, of not reading other languages than their own, or perhaps not knowing that there are other languages than their own. I may say that whenever I want to know anything about alternating currents, before I understand it, I am obliged to sit down with my pen and go over the whole thing, as I did this afternoon—not understanding the terminology, I worked the thing out myself and presently I saw what was meant by all the terms. But I seldom spend very many weeks on a problem until I have looked over Mr. Oliver Heaviside's papers. Generally the solution is there. It is so in this case. It shows the advantage of being forewarned. Mr. Oliver Heaviside, of course, claimed some time ago from purely theoretical grounds when nobody was looking at him except Sir William Thomson, (I was looking at him too, but I will not name myself in this connection—I was one of the forty-nine who sent for a copy of his papers and got one), that the self-induction of wires was a very important factor in alternating current work.

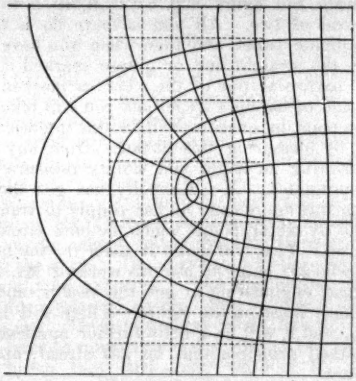
I will now leave this and say that I enjoyed this part, and am glad that it has been done. It must have required an enormous amount of labor, and, after all, the conclusion seems to be that it *practically* does not amount to much. It has been a good exercise for Mr. Kennelly, different from what falls to the lot of engineers in general. As I say, Mr. Heaviside was one of the first to maintain from purely theoretical grounds that the induc-

tance of wires was very important for telephony and other things. It had been claimed by the dominant school, the government school, in England, that self-inductance was hurtful and could not do any good. Mr. Heaviside said otherwise. If Mr. Heaviside's controverters had had their way, probably there never would have been any long-distance telephone lines in the world.

Another thing that struck me in this paper was the power of abbreviation. As I say, I am not used to those terms. Some of them I have used a good deal, but these words in "ance," and these vectorial methods struck me a little strangely. But I soon saw what they meant. However, the problem, as Dr. Pupin has said, is simply the problem of an elastic string moving in a viscous medium. If it is stretched the required amount and fastened at the end, it vibrates in nodes and loops; but if there is a viscous medium, there is a damping, and what occurs here in the wire and in a string moving in a viscous liquid is that the velocity of propagation is not the same as it would be without viscosity. Instead of having perfect interference and getting perfect nodes, which do not appear in the figure, the waves going and returning being damped, do not completely neutralize each other, and the result is that there is never any reduction to zero.

Now to come to my criticism. I think Mr. Kennelly has overlooked one point. It occurs very frequently in mathematical physics that the differential equations involved are very simply solved—as in the case here, an exponential or trigonometric function will solve the differential equation. But the difficulty occurs, that in every problem, besides having a function to satisfy the differential equations everywhere, it must satisfy certain boundary or terminal conditions. Mr. Kennelly has considered the case of insulation at one end or connection with the ground. Those are very simple. What you want to know, I suppose, about a line carrying an alternating current is what will happen when there is a motor at the farther end. He has spoken of some lamps, but that he has not treated separately. Now, if you put a motor on there which holds back, there is certainly a difference. Imagine the case of the string. It is obviously a very different matter about pitch, wave-length and all that, whether you have the string fastened rigidly to two pegs at the ends, or whether you have it fastened to a weak spring representing capacity. If it is fastened to a weak spring, and you shake it at the other end, you do not have sharp reflections. On the other hand, if you have it connected to a weight which has inertia, there is another change in the motion—the reflection is different still. In the case of an alternating current motor, there is certainly self-induction. Now these things must produce a reaction there on the line, and cause a change of phase and giving out of power and all that. It seems to me, that it must be treated quite by itself.

Finally I am always delighted when I see a subject of pure mathematics brought into the field of applied physics, and especially by an engineer. The most brilliant case I recall of that kind was in the case of the French engineer Saint Venant, who solved most beautiful problems in elasticity and got formulæ which are now used by every engineer, I suppose. All engineers before had used an empirical method. The method that I speak of is the same there as here—the method of the application of the principle of the conformal development of one plane upon another. Perhaps some of you wonder how Mr. Kennelly got this Plate I. I did too, but I can guess. In Maxwell there is a chapter on the theory of conjugate functions. The point is to find in two planes points corresponding to each other, so that every line in one will correspond with a line of the other, and



Curves $x =$ const.

Curves $y =$ const.

FIG. 12.

$$x' + i\,y' = \log (x + i\,y).$$
$$x + i\,y = \cosh (x' + i\,y').$$

x', y' are rectangular co-ordinates in this diagram.
x y " " " " Kennelly's diagram.

the property is that all angles made by corresponding lines are preserved in the two planes. Here we have the case of the x and y lines in one plane corresponding to the ellipses and hyperbolas in the other plane. This is done by the use of the analytic function, $\cosh (x + i\,y)$ which gives this development. Mr. Kennelly's result has been that you have to measure—having one curve $x = .2$, and the other, $y = .7$ corresponding on this diagram to the ellipse $x = .2$ and the hyperbola, $y = .7$; their point of intersection corresponds to the point of intersection of the straight lines, $x = .2$ $y = .7$. If we go one step farther and transform this plane again so that the circles in this plane go into straight

lines in a third plane, and the radii which cut these circles at right angles go into straight lines cutting the straight lines just mentioned in the third figure at right angles, we shall have to see what these ellipses and curves transform into. Mr. Kennelly will find the picture in Maxwell, and instead of having to draw an infinite plane he will have to draw only a strip of a finite width, 2π, which will represent the whole thing. See Fig. 12.

The axis of abscissae here comes into a line in the middle of the figure and goes off to infinity; the middle of the figures go off into infinity and the ellipses go into curves like this, which come around that line. These ellipses pull out here more at the left, and these hyperbolas, which cut these ellipses at right angles, go into lines which cut these lines at right angles. Now you will not have to draw these extra sets of radii and circles which complicate the figure and cover it up with four sets of curves instead of two. All you have to do is to put this figure on coordinate paper, and then when you have measured off, instead of the straight line or ellipse marked $x = .2$, you will have the particular one of these curves marked with that value, and instead of taking a hyperbola you will take this other curve, and the point in question will be the intersection of the two. Instead of measuring this distance from any particular point and measuring an angle you simply measure these two rectangular coordinates. Mr. Kennelly has got the work all done in making this figure, and he has simply to transform this figure into that by taking points which lie on a circle here and marking them off. That will make it easier for the members of the INSTITUTE who are going to use this work of Mr. Kennelly's in their practical engineering to get the results, and they will not have so many lines on the figure. There will be nothing for them to do, and it will be a little further application of the same mathematical principle that he has already applied and might apply here.

MR. CHARLES CUTTRISS:—While I am not going into the mathematical discussion of this question, I would like to say that if I understand the remark of the last speaker correctly, he said that the curves described by the waves travelling through a cable, keep up a uniform period but merely flatten out in a perfectly uniform manner as they travel through the cable.

I would say that I have proved by experiments that this is not so. The cable experimented upon was over 840 knots in length and the experiments were made for reasons that were very remote from the purpose of this paper.

You will hardly call the period or rate at which I transmitted the current, alternating current; they were about 80 per minute.

The potential began from zero, went up to 40 volts and came down absolutely in the same manner by the same gradation and time in which they went up, and a record was taken at the distant end of the cable on a siphon recorder. The wave, instead of going up in a perfect curve, such as you would imagine

and coming down on the opposite crest in the same curve, went up in an approximately perfect curve to the apex which was prolonged. The curve then dropped more suddenly to its zero, and in so doing, described almost a concave. This same formation is maintained in larger or smaller curves whether the speed be about 80 periods per minute or 360, the latter speed being the maximum at which I could transmit.

I do not know whether I have described the shape of the curve clearly, so I will try and put it upon the blackboard.

The curve, as you might imagine, rising from zero to 40 volts would be a perfect curve like this — instead of which its shape is more like that.

FIG. 13.

Now, that will prove that it is not the same as the pulling of a string and getting the same movement, only growing flatter and flatter as it travels along.

I have tried for a long time, for purposes which I cannot mention, to obtain this perfect curve, but hitherto have not been successful.

DR. WEBSTER:—If I may be pardoned for replying to the objection of Mr. Cuttriss, he has quite misunderstood what I said. I by no means stated that the thing would be the same all along the curve. The curve that he has given there is exactly what might be expected. The differential equations are the same as for a wave of water. You have seen the waves running along at sea. They look very much like the sinusoidal wave that we have so much in physics. But when they come in shore on the beach they curl over just like Mr. Cuttriss' picture. There is a figure like that. I cannot say exactly where it is, but I would be willing to wager that there is something on that in Mr. Heaviside's paper. But I am extremely glad he has experimented on it. I have often thought that if I had only some pull on a cable or cable official to make a few experiments I should be only too delighted. I want to ask Mr. Cuttriss a question I never have been able to ask anybody, because I never knew anybody who was in a position to answer it, that is, what is the self-induction of a real submarine cable per mile? If he will tell me that, I shall go home pleased.

MR. CUTTRISS:—That is something that has never been worked out.

DR. WEBSTER:—I have been engaged in experiments for quite a while on electric waves and such things, and I have got the apparatus for determining exactly that thing, if I only had the cable. I never expect to have the opportunity of doing it.

If it could be done, and if there was such a thing as a cable which was out of business for a few hours or a few days, we could learn a lot, and I am sure it would be extremely worth while. If there is anybody here that wishes to present a few million dollars or a cable to Clark University or any other, I should be very glad to lend my apparatus to have this done, and I am sure it would be worth while.

MR. CUTTRISS:—I beg to say that the great trouble is that you cannot be at both ends of the cable at the same time.

DR. WEBSTER:—I do not want to be. I have been planning a long time, in fact at the Congress in Chicago, two years ago, I announced my paper. I had done enough preliminary experimenting to think I had got the facts I wanted. I had the wires that came to the same thing as a cable, and I thought I had the results about these waves, but they were so extremely short, something like two or three millionths of a second, that I afterwards called myself down and withdrew the paper. I have not yet been able to get the wires up, and as Mr. Cuttriss said, get at both ends at the same time. But I can assure him it is not necessary to do that, and I think we can arrange the experiment at one end so that we can get all that we want to know.

DR. PUPIN:—Mr. Cuttriss remarked that in this case we have no resemblance between the pulling of the string and the actual propagation of the wave. Neither should we have, because in the case of a submarine cable, the self-induction is very small, and it is just like jerking at a string whose weight is small in comparison to the viscosity of the medium in which it is moving. Therefore in this case again, the fundamental equation reduces itself to the same kind which describe the conduction of heat. The analogy of the vibrating string ceases, passing into the analogy of conduction of heat. We pass from one physical phenomenon to another, from the vibration of the string to the conduction of heat. So far as the experimental work is concerned, Foucault and some French engineers have experimented on the transmission of signals through air lines, and they found the same difficulty that Mr. Cuttriss found in Atlantic cables, namely that the shape of the wave as it is put into the line at the sending end does not resemble very much the shape of the wave which appears at the receiving end. They found, unfortunately, that although they put in at the sending end a very sharp signal, at the receiving end that signal was not sharp, but it came just like a steep wave front, and then it dragged out into a more or less elongated tail; so that they really could not thereby determine the exact time at which the wave had arrived at the end of the line. But no experimental work has ever been done on these matters in the laboratory. Telegraph lines are always busy, and it is very difficult to perform experiments and be at both ends of the line. But experiments of that kind can be performed. We can make, without very much trouble, artificial

cables representing long air lines in all the particulars; that is having so and so much resistance per mile, self-induction per mile and capacity per mile, if we simply take the trouble; and I think it would be quite worth while to make some experiments in that direction, especially since the problem is very important and no experiments have ever been made in that line of work.

THE PRESIDENT:—If there is no other discussion, as the hour is late and there is another paper, I will call on Mr. Kennelly to close the discussion.

MR. KENNELLY:—The criticisms which have been raised are speedily dealt with in this case. First of all, in regard to terminal conditions, the head and front of the offending in our paper is alleged to be that, while we deal with an insulated line, and have also dealt with a grounded line, we have not considered the countless conditions that may practically arise where a line is neither insulated nor grounded, but is in some intermediate condition. If, however, you will examine formulas 3 and 4, you will see that they take into account every possible condition, providing of course, that the currents and electromotive forces are sinusoidal. We have, unfortunately, to make that assumption, which is not justified in every practical case, as we know. Look at equation 3, for example; the electromotive force is composed of two terms, the first of which depends on the terminal electromotive force, and the second on the terminal current. If the terminal conditions require that the lag in phase of the received current is a given number of degrees, insert that number of degrees in the current and the results obtained will be applicable to all points on the line. No lag was assumed for the current in Plate III, because there was no object to be gained by the selection of any particular phase difference between the received pressure and current. But of course, it is evident that any apparatus, as for example a transformer or a motor, when supplied with, say a thousand volts at the receiving end of the line, will take a certain number of amperes at a definite lag for any given load, and one is supposed to know experimentally what the lag at any given load will be. If we know this relation for all conditions of load, we simply have to interpolate in equations 3 and 4, in order to determine the pressure and current at any point on the line, provided it can be safely assumed that the current is sinusoidal. Of course, in a transformer or motor, the current is not usually sinuosoidal, and of course, our formulas fail just to that degree. But we know also that we can make certain assumptions in regard to the deviation from the sinusoidal condition of even waves of current that have been distorted by hysteresis. We know that when a current is distorted by hysteresis in a transformer, we can separate the complex wave into two waves, each nearly sinusoidal, and this analysis will very closely represent the actual condition of affairs. I need only refer to Mr. Steinmetz' work

in this direction, as presented at the Philadelphia meeting last year, to show that that is the case, and therefore we claim that our formulas deal with every possible terminal condition. In the paper we have only illustrated a few terminal conditions, for the sake of simplicity.

We do not claim that we have deduced any absolutely new principles. We know that the fundamental principles dealt with in our paper have been developed long ago; but what we do claim is that we have presented them here for the first time in a simple and practical engineering form.

Now in regard to Plate I, and the question of the way in which it should be most conveniently drawn, we cannot agree with the suggestion of Dr. Webster, for the reason that what we seek is not the rectangular coordinates of a hyperbolic sine or co-sine, but its polar coordinates. In order to draw that diagram, we had to send to Europe for a machine. We could not find anywhere in this country a machine which would draw the lines accurately enough.

In regard to the question that Mr. Cuttriss has mentioned, of course his problem is entirely different from that which we here consider. He is dealing with signals representing the trace of current as they proceed over a long cable. We deal with the effective electromotive force and current, and not with the trace of any single wave. Those waves we show are simply photographs, so to speak, at any moment, of the effective alternating current pressure and current strength at all points along the line, and at all moments that condition will be maintained, although everywhere the current is alternately reversing in direction. We do not of course show what the trace would be of alternating current waves, as recorded for example by the siphon recorder.

WM. MAVER, JR:—(*Communicated after Adjournment.*) I desire to express my appreciation of the valuable paper which Messrs Houston and Kennelly have brought before us. It is doubtless true, as several of the participants in the discussion on the paper stated, that to many it will require considerable study before it is thoroughly digested and assimilated in its entirety, but fortunately the paper is on record and, therefore, accessible for study. Furthermore, there are numerous points brought out in plain language and others illustrated by numerical examples, which require only an ordinary understanding to grasp them.

Furthermore in my opinion, the paper is not only valuable but it is also timely, for so much has been said or intimated concerning the direful possibilities of the effects of resonance that some of us had almost began to think, despite years of practical experience with alternating current circuits, having considerable capacity and inductance, that some fine day resonance would astonish and confound us by upsetting things generally. For example, it was only recently that I was informed that resonance

had been held responsible for the failure of the insulation of an underground alternating current circuit in a neighboring city, which was proven by the fact that, upon changing the route of the circuit, the cable in question no longer broke down.

As my experience of over six years with more than fifty such alternating circuits, representing a total length of about 300 miles of underground cable, had not disclosed any similar case, I was considerably nonplussed. It is therefore reassuring to learn from Messrs Houston and Kennelly's calculations, that the maximum increase of voltage due to resonance on a circuit such as the one I refer to would be, under the most favorable conditions, about one volt.

The paper further shows that even on the very longest aerial circuits the devices which may be provided to protect the insulation from the effects of lightning discharges may safely be left to deal with the increased voltage due to resonance.

THE PRESIDENT:—We will now have the second paper, by Professor Anthony, on Underwriters' Rules.

The paper was read by the author. (See page 228, April issue of TRANSACTIONS.)

Discussion.

The President:—Professor Anthony's paper is now open for discussion.

Mr. C. O. Mailloux:—This paper, with its unimposing title and modest dimensions, is I think one of the greatest importance to electrical engineers. I do not wish to disparage the preceding paper, and it ought not to be any disparagement to say that the paper we have just heard is at least of equal merit, great as is the value of the preceding paper; because although the question of electric wiring is one which seems a relatively simple matter in these days of sines and sinusoidal functions, yet it is one which, when we come to the practical and commercial side of our profession, we have at one time or other to deal with; and there are those of us who have extensively to do with it. I think that we should be very watchful of the construction which is placed upon the rules formulated by the different insurance companies. They may be working for the purpose of making the electrical business better, but that is with them only an incidental consideration; they have not the interest in so doing that we should have. Their interest is primarily to see to it that the installation is made safe from fire. We have a further interest. We have some interest in seeing that the installation is perfect, not only electrically but practically, and that it is a credit to the profession which it represents. I am very sorry to call the attention of this body, (or at least some of the members of it who may not be familiar with it), to the fact, though many of you are familiar with it, that in the matter of insurance rules electrical construction has been handled with a spirit of inconsistency and partiality and with a want of that broad liberal treatment that characterizes other lines of fire inspection. This case, of the Attix wire, is perhaps as good an instance as any, and it ought to be one sufficient in importance to call the attention of electrical engineers to the necessity of our acting, either singly or jointly, in such a manner and with sufficient emphasis, as to let our voices be heard and prevent the continuance of such inconsistencies.

As the paper very clearly puts it, it strikes one as almost absurd to characterize or define as a *tube* a piece of wire which has a solid wrapping of some material supposedly fire-proof, applied to it. It is no more a tube than would be any other wire on which might be put a covering braid or some other material than the insulation. I do not see why a simple braid or a simple tape really is not as much a tube; yet we have found ourselves tied hand and foot in many cases by such rulings as that, on the part of insurance inspection authorities. I might mention a dozen cases in my own practice which are equally incongruous, equally absurd, and which have caused needless delay, needless expense, trouble and annoyance. I think it is time that the

INSTITUTE as a body should protest against a continuance of such rules and such measures on the part of insurance companies. I may state with pleasure that I have heard several representatives of distinguished and prominent insurance companies express themselves in no uncertain terms in regard to the manner in which this work has been done by those who were supposed to represent them and do their best for their business. I have stated to some of them that it has an evil influence on their business. I know of cases where the insured has preferred to do his own insuring rather than submit to the arbitrary dictation of the insurance inspectors. Some of the insurance companies themselves have expressed their dissatisfaction; and they feel, in some quarters at least, that there ought to be a change in policy; that insurance rules ought to be compatible with, and favorable to progress in electrical installations, rather than obstructing it.

MR. WILLIAM J. HAMMER:—I am heartily in sympathy with the gentleman who presented this paper and the gentleman who has just spoken. I think that subjects of this character are of the utmost importance to the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. At the last annual meeting I had the honor as the Chairman of the National Electrical Light Association's Committee on Standard Rules for Electrical Construction and Operation to present their last report to the INSTITUTE with the request that a committee be appointed to examine and endorse it on behalf of the INSTITUTE in order to secure fuller cooperation and a better enforcement of these rules. Two gentlemen appointed on the committee of the INSTITUTE and who are among the most honored members of this body made the statement to me at the time that they thought it was inadvisable for the INSTITUTE to take up a matter of this kind, because it was purely a commercial one, and the INSTITUTE was a scientific body. In this connection I wish to say that I heard some one make the remark recently that many members in the INSTITUTE thought it was hard to get papers before this body which were within five miles of the earth. I think we have had admirable papers of the character that have been read to-night by our worthy President and Mr. Kennelly, but there are also other papers which reach a very large percentage of the members, are of vital interest to the professional work that a good many of us are engaged in; and I am particularly interested in this class of work, having been identified for a number of years with the work of the committee of the National Electric Light Association which promulgated the rules now practically used all over this country by the insurance people generally, and I might add without any credit to the organization that brought them out. I think severe criticism can be made justly upon the underwriters for allowing their inspectors or their experts to bring out rules of this character and pass them and foist them upon electrical engineers and the public at large. I think many of these things have not been

treated in as conservative a manner as they might have been. Last year a very earnest effort was made to secure the cooperation of all the electrical interests, including the insurance inspectors, etc., with a view to having one single set of rules go out, having them more rigidly enforced, and having them kept up to date—those efforts, although very earnest, were not brought to a conclusion. Since that time the committee has continued its efforts, and before very long, the committee of the National Electric Light Association, who are recognized as the ones who have brought this subject to the front for years past, will extend a formal invitation to the representatives of the telephone interests, the street railway interests, the Fire Chiefs' Association, the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS and perhaps some other association or two which will be interested in seeing that proper rules which are conservative in their character and which do not benefit any particular class of manufacturers or any particular industries to the exclusion of others, are adopted; and it is hoped that before this year is out some uniform action will be taken by these organizations which will look to just the step that Prof. Anthony and others have recommended and which is certainly highly advisable. I merely refer to this now, because very earnest efforts have been made during the past year and they are being pushed very actively by a committee of the National Electric Light Association acting in conjunction with some of these other gentlemen, and the matter will be brought before the INSTITUTE as well as these other bodies within a short time and in a manner which I trust will appeal to them and be treated as being of such decided importance to the electrical interests for the INSTITUTE OF ELECTRICAL ENGINEERS as well as other bodies to cooperate with the National Electric Light Association in its important work.

MR. H. WARD LEONARD:—This subject is one that has interested me for a good many years and I am familiar with the difficulties that have always been met with by contractors in dealing with the rules set forth by the underwriters and the requirements that they lay down. Having installed a good many hundred thousand lamps on different styles of wiring in the past ten or twelve years, I feel that the use of anything such as has been described in this paper as the Attix "tube and wire" is certainly a distinct reversion to the conditions that applied to electric light wiring in about 1885 or 1886. I personally installed work at that time which was done with practically identical materials, and which I think were as good as the Attix tube and wire can be to-day, and it seems to me that the conduit is an essential condition for thoroughly first-class work to-day, and that a conduit to be of any service whatever must be a permanent, reliable, strong tube which will be always there, enabling you to pull the wire out and in, in case of any failure of the wire. I personally am very strongly a believer and always

have been, at least for a great many years, in placing the opposite poles of a circuit, whether it be a two-wire circuit or a three-wire circuit all inside of a single iron pipe, and I have put in some thousands of lamps in this city in which both poles of the circuit are inside the single plain iron pipe, with quite satisfactory results; and I wish to call attention to a point which may not have impressed itself on all the members, and that is, that in case you do have both poles of the circuit inside of the iron pipe and the system of iron pipe be grounded, it is almost inconceivable that any condition of leakage or trouble in the electric circuit should occasion a fire. In other words, it is my belief that the rules of the underwriters which they have so strenuously urged for the last few years, that when conduits are used that only one wire be placed in each conduit, is merely aggravating the possibilities of fires which could be eliminated by using first class insulated wires inside of a single, metallic conduit. The underwriters apparently have been convinced of this point comparatively recently and have waived that requirement where the wires are placed in an armored conduit. As an indication of the difficulty of securing attention on the part of the underwriters to those whose voices ought to be heard in practical matters relating to electric work, I will say that there exists in this city an association of nearly all of the representative concerns of electrical contractors, and feeling that the underwriters had imposed very arduous and unreasonable rules and in fact conditions which made it more expensive, more difficult and more dangerous to do electric wiring work, the contractors in question appointed a committee when they learned that the underwriters were likely to issue a new set of rules in the then immediate future. They appointed this committee to wait upon the underwriters for the purpose of aiding them in drawing the rules and in arriving at rules which would be mutually satisfactory, and I happened to be chairman of that committee and so can speak about it from my own knowledge. A letter was sent to the underwriters by me as chairman of this committee, expressing a desire to participate in their discussions in regard to this matter, or at least to be given an audience to express our views in regard to some of the points which we hoped would not be inserted in the new rules and which we had considered arduous in the old rules, and the letter was acknowledged with the statement that in case they cared to have any conference with us or to hear any expression of opinion from us, they would let us hear from them, which we never did. I am heartily in sympathy with the general tenor and purpose of this paper and believe that this INSTITUTE is by all means a proper body to express its opinion in regard to matters having so practical a bearing on the work of electrical engineers.

MR. FRANKLIN S. HOLMES:—I am in hearty sympathy with the paper, and am also disposed to criticise the position occupied by the Board of Fire Underwriters.

I understand the Board to be an organization of business men formed to protect its business interests by issuing and enforcing such rules as will reduce fire risk. Its field is commercial, not technical, and when it deals with technical matters it is liable to act foolishly. As an instance in point, compare the three tables, showing the safe carrying capacities of copper wire, which have been published by it within two or three years. We find that the carrying capacity of a given wire varies nearly a hundred per cent in these different tables. See also the unreasonableness of the Board's rulings in the matter of pipe conduits. It prescribes that iron pipe carrying duplex conductors must be lined. And yet if we ground or short-circuit a service, carried in a plain iron pipe and protected by a 25-ampere fuse, by no possibility can we heat the pipe dangerously hot, at any point in its length. The lining of a pipe, for small conductors at least, does not affect the fire risk one way or the other, and, therefore, the Board should make no such sweeping rules on the matter. Similarly, in this question concerning Attix wire, its ruling is partial. Any continuous duct into which wires are, or may be, drawn after a building is completed, whether it be paper tube, brass covered conduit, canvas jacket, or iron conduit, are each and all better than plain wire protected however thickly by a pervious insulation. The insulation of the Attix wire is pervious, and in no sense can such protection be considered as the equivalent of a duct, however fragile or strong. I repeat, I think the Board of Fire Underwritecs has limited duty to perform and should confine its action to impartial rules in matters involving fire risk only. It should leave devices and methods which pertain to excellence of construction to others whose business it is.

I am very glad to hear that there is a movement on foot which will effect a conference of all parties interested in raising the standard of electric light installations. I hope the result will be first, a more rational set of general rules, and second, a strict definition of the functions of the Board of Fire Underwriters with reference thereto.

Mr. James Hamblet:—It came to my notice a short time ago that certain buildings in the city of Brooklyn were wired for electric lights and inspected by the inspectors of the Board of Fire Underwriters and approved. The lights were used for a time, and then a certain time after that inspection, they were again inspected and condemned, and the owners were compelled to re-wire their buildings or improve them according to the new rules adopted by the same Board of Fire Underwriters. I also know a similar instance in Brooklyn where a contractor made an estimate for the work and the inspectors were watching him, and the inspector told him that by the new rules a certain new kind of tube was to be used and he must put in that kind of tube. That destroyed his profits on that little job.

MR. W. J. JENKS:—I feel a great deal of interest in this paper which Prof. Anthony has read, not alone because I am thoroughly in sympathy with the views which he expresses, but also because I think the discussion of the general subject of the relations between the electrical engineering profession and the fire insurance underwriters may, if now taken up by the INSTITUTE, become very profitable. I have had some little experience in representing the incandescent electric lighting industry in discussions with the insurance people during the past twelve years. In 1883 representatives of the underwriters came to study the arrangement and operation of the first three-wire underground system in the world, at Brockton, Mass., of which I then had charge. In 1884 the first schedule of insurance rules adapted to the necessities of incandescent electric light construction of central station systems and isolated plants, was issued by the New England Insurance Exchange, as the result of a careful study of actual conditions by Capt. William Brophy, who was then their inspector, and Mr. S. E. Barton, who was then chairman of their electric light committee. In formulating these rules the New England people followed the example which had been set for them in 1881 by Mr. W. H. Anderson and his associates in New York, in their issue of the first rules adapted to series systems of arc lighting, in that they sought information of those who engaged in the practical work of installing electric lamps, and encouraged suggestions from such people as to revisions which the rules might require. This policy of mutual consultation and cooperation was explicitly adopted by Mr. Edward Atkinson in 1882 when he was president of the Boston Manufacturers' Mutual Fire Insurance Company. Cooperative efforts of this sort have been the rule during all the subsequent history of the art, and in proportion to the cordiality of the relations between the insurance companies and the electric lighting and power people, has been the correctness of the form into which insurance opinions have been moulded. There are a great many examples in the rules, of the truth of this statement, and while I fully appreciate the differences which now exist as set forth in Prof. Anthony's paper, I think the instances thus afforded and the remarks which have been made to-night, should be considered as local rather than as general in their application. The cordiality which has, as a rule, existed for many years, was well illustrated when in August, 1890 at Cape May, two or three days in advance of the meeting of the National Electric Light Association, a committee from that Association met representatives from some of the individual electric light companies and a number of executive men representing the Underwriters' boards of different parts of the country, and chose a sub-committee to collate all the available information as to requirements of the underwriters throughout the United States and formulate a revised code. I happened to be one of the members of that sub-

committee, and the results of our work appeared in the arrangement of what is now the National Code, first adapted by the Western Union Fire Underwriters' Association, then by the National Electric Light Association, and finally (with some modifications) pretty generally by the different boards of underwriters throughout the United States. I believe this code did not appeal to the necessities of the New York Board of Fire Underwriters, or perhaps it might be more correct to say that it is the record of the growth of the business, that the New York Board has desired to have rules which were unique, differing essentially from those which other people were satisfied with. There are several evidences of the correctness of such a theory in the rulings which have from time to time vexed the souls of electrical engineers who have been unfortunate enough to find themselves under the surveillance of some of the inspectors in the Metropolitan district. Other members of the INSTITUTE can, and I have no doubt will, give detailed testimony upon these points. But I believe it will be found that looking the country over, the insurance people are disposed to maintain a feeling of hearty accord with all electrical engineers who are worthy of the name, and in addition to this, to boil down their rules so that they will come to be short schedules of methods which are dangerous and therefore are prohibited, rather than manuals of instruction for the guidance of constructors who know a great deal more about the business than the underwriters ever expect to learn. I remember that as early as 1887 Mr. Barton, to whom I have just referred, who was at that time more intelligently informed in these matters than almost any other active insurance man in the country, by reason of his close contact with electrical central station men, said in an official report.

"Were we again to begin at the beginning, with our present "knowledge, we think we would be inclined, in justice to all "concerned, to issue rules setting forth those practices that we "would *not* permit, rather than stating in such complete detail "what should be done."

My own feeling has been for several years that the underwriters would ultimately come to the point of issuing a list of commandments as to what the electrical constructors should avoid, leaving us to elaborate a set of rules such as have been spoken of to-night, to teach young engineers in detail what they should do in order to secure the best practical results, and I think that list of commandments should begin, as do the most of those delivered to Moses in the olden times.—"Thou shalt not."

MR. MAILLOUX:—I do not think that this subject can be disposed of in the time that remains for this discussion, and for one I feel that I would like to have an opportunity to collect my ideas. I am under the weather this evening, with a cold, and can scarcely formulate my ideas as I would like to. There are one or two facts in connection with the matter which I think

it might be well to bring to the attention of the meeting and which may serve to stimulate discussion. I the first place I would like to call attention to the fact that the insurance companies themselves are not entirely satisfied with the way the matter has been arranged, and at present out of some forty or fifty insurance companies represented in New York City, there are nearly one-half who have formed a little insurance inspection association of their own; they are no longer satisfied with the inspection made by the official underwriters, but have an inspector of their own. I am very sorry that their inspector is not here this evening, as he is a member of the INSTITUTE and could give us some very interesting information. I trust that he may have an opportunity at another meeting to give us his experience which is, I assure you, quite interesting.

Gentlemen, I feel quite strongly in this matter, because I have had a great deal of experience with the insurance inspectors, not only in this but in various districts, and as Mr. Jenks has very well observed, I found a noticeable difference, of which I will give you one instance. The iron conduit tube was adopted by the New England Insurance Exchange in June last. I had occasion to communicate with them with reference to a large installation at Newport which was in their district. I had found that their rules would not allow me to use an iron conduit, although there were certain electrical and other objections to any other forms of conduit which might be allowed under the rules. I stated the case, urging the electrical objections and the mechanical ones as well, and received a reply the next day stating that the objections were well taken, that they had been submitted shortly before by others, and that it had been decided to allow the iron conduit tube to be used with twin conductors for such cases. Some four or five months afterwards, I had occasion, in connection with several installations contemplated in New York City, to go over the same matter. A question came up almost similarly. I went in person to consult with the officials of the inspection department in New York and was informed by them that they had as yet taken no action in regard to the iron conduit tube; expressing at the same time grave doubts as to the propriety of their taking any action whatever. It seemed to them to be something that was of very doubtful, if any, utility, if not absolutely bad. However, in the same breath almost, I learned that the Attix tube, so called, was then allowed. This was several months before any official promulgation of this "Attix" rule was made, as this conference took place some time in October or November. You can scarcely imagine the feeling with which I heard this announcement. I could scarcely believe that we were in a metropolis and in a progressive age when I heard that we were going to be relegated by official direction back to methods which I, for one, should not sanction. I will state, that as a member of the examining board of this

INSTITUTE, I would not want to acknowledge or accept as a member, a man who was capable of admitting Attix wire as the rule prescribes. I would consider that he was doing something derogatory to the profession. Although we are still far away from the ideal and the perfect, we who have had practical experience with the different ways of interior wiring, consider the iron conduit tube such a great step in advance that we hailed it with a certain degree of delight, but we were literally told that we must not touch that. Now I submit that when we reach such a point, that the progress of our profession is retarded by arbitrary methods such as these, it is time for us to act. I will give you another case which is quite interesting. I have now in hand a case where the insurance inspectors inspected a large dry goods establishment in Brooklyn. I was called in by the proprietors of the establishment after they had made efforts during several months to adjust the matter with the insurance companies—I was called in by them to see what could be done in the matter. It took me three months to bring about a conference between the various insurance inspectors interested in it. There were some twenty odd companies who carried partial risks on the establishment, it being a very large one. I discovered very quickly that some of these inspectors wanted certain things done and other inspectors wanted that very thing not done, and so on, for a long list of requirements; yet they were all working from the same rules. Some of them told me that I must not allow any moulding to be capped. Others said that that was very wrong; —the rules required it to be capped; and so on through a long list of inconsistencies. I began in June. In October I succeeded in bringing about a conference between the different insurance companies at which I appeared as representative of my clients, I took delight in calling the attention of the seven or eight inspectors present to the fact that they were extremely inconsistent and arbitrary. I put it in those words and stated my reasons clearly, and this particular case furnished me ample reasons. I think it had a salutary effect; a certain agreement was drawn which stated what these inspectors would all agree to agree or disagree about. I had made so many efforts to satisfy them all that I had given up hope of doing so, and I thought all other efforts useless until I had their signatures as evidence to what they would or would not allow. It was no longer a question of rules. It was a question of what their individual preferences or whims might dictate. Now, gentlemen, I think that the electrical profession needs some attention, when it is placed in such a position as that. I think that not only looking at it from a scientific standpoint, but also from the standpoint of dollars and cents, it will pay us to go to the bottom of this thing. I believe that with the proper amount of suasion we ought to be able to place ourselves in a position where instead of being dictated to we may ourselves dictate to some extent what is proper. I do

not think there is a more competent body in the United States to formulate rules and restrictions, to prescribe what is a proper thing to do in connection with electric wiring, or what is proper and desirable from the engineering standpoint. I submit that men who are business men merely, though they may have experience, are not so well fitted as those who have had the training and the experience of years, to do this. I think that with all the scientific men and all the practical men that this INSTITUTE contains, it is more competent than any other body to dispose of this question. I am in a position to assure this body that it has sympathy from the outside, that it has sympathy from the very ranks of the insurance companies, which is saying a great deal; because I have already called to your attention the fact that they have dissenters, men who are dissatisfied with the way their business is transacted, and they are only waiting for a word of sympathy or encouragement or some little energy on our part and on the part of all the other associations interested in the electrical industries in order to give us a helping hand and bring about the desired change.

MR. JAMES I. AYER:—It is very gratifying to me, having worked with the Electric Light Association in relation to these rules for some years, to see the interest taken by the INSTITUTE in this matter. I think that if any additional arguments were needed I can cite a case which perhaps touches the engineer a little more directly and forcibly than some of the points made to-night; that is the tendency of the inspection department of the Board of Fire Underwriters to usurp the prerogatives of the electrical engineer; in other words to issue certificates to contractors which pass as current coin as evidence that they have got what they paid for—a first-class electrical installation. There is not an engineer here engaged in practical work who has not run against it, who has not seen passed what should not have been passed, and the investors, the men who are paying for the installations, would have been very glad to pay the engineer's fees if they did not feel that they were getting something for nothing from the Board of Underwriters. A case of that kind came up only a few months ago where a very large installation was being made. The specifications were made partly by the manufacturing company and by the architect who had a little assistance in getting them out. But after the contract was awarded, while there were unusual electrical problems involved in the construction work, the parties paying for the installation declined the services of an engineer because they thought they did not need one. They had a competent contractor and realized that it was all right. Later on, when the installation was about to be completed, some comments were made by engineers who observed the work and said it was bad and all that. The question was raised in the Board of Directors—it was a very large corporation—as to whether it was all right or not. Some thought it

was; they advocated the acceptance of the contract as tendered by the contractor, but the point was raised that there was a lack of thorough workmanship. Immediately, the contractor brought in the argument that the insurance certificate that he possessed was an evidence of what they had got; that tney had everything that they could demand or desire under the contract. The work was accepted. A month later they paid a considerable fee to an engineer to tell them what the matter was—why they could not successfully operate the plant. It took about $20,000 to correct the evil, and they paid an engineer to tell them how little value an insurance inspector's certificate is. It is not often they come out that way—that the engineer profits in the end by it. But it is a fact that the fire underwriters are stepping into the shoes of the electrical engineer; they are interfering with his profession, his businesss, and I know, as Mr. Hammer has well said here, some of the members are anxious to have papers read here that would "get within five miles of the earth occasionally." We all know that this question of insurance rules was regarded by many as something beneath the dignity of the INSTITUTE. It has been so expressed; it has been so treated. But I think that as the thing has taken shape it is clear to all the members that it is essential that this INSTITUTE take some definite action.

MR. W. J. JENKS:—I want to suggest that we have with us to-night a gentleman who, though not a member of the INSTITUTE, is well-known to almost all of us, at least by his reputation, as one of the most experienced insurance men in the United States, in those relations with the electrical people which we are now discussing. I refer to Mr. C. J. H. Woodbury of Boston, for many years Vice-President of the Boston Manufacturers' Mutual Fire Insurance Company, and now connected with the American Bell Telephone Company. Mr. Woodbury now stands in a position where he can without prejudice give us accurate information in regard to the actual feeling of the underwriters toward the electrical business, and the steps that are now being taken toward the end which has been considered in this discussion so desirable of attainment.

THE PRESIDENT:—We should be pleased to hear from Mr. Woodbury. I trust Mr. Woodbury and the members of the INSTITUTE will excuse the President who has to go to Philadelphia to-night and must leave now in order to catch his train. I will ask Vice-President Hamblet to take the chair.

The President then withdrew and Mr. Hamblet took the chair.

MR. C. J. H. WOODBURY:—I came here this evening as a guest and to listen, not expecting to take any part in debate. My former position for a number of years was in technical relation to underwriters of manufacturing property, and I had occasion to have an intimate knowledge of the policy of the insurance companies in regard to electric light and power installation, and as that is now with me something of the past, I can perhaps look

at the subject from a disinterested standpoint. There were a great many electric lighting rules, so called, made by local bodies of underwriters, at times conflicting bodies. In 1893, shortly after the last issuance of the rules of the National Electric Light Association, there was formed in Chicago what was known as the Underwriters International Electric Association, the name of which has since been modified by the change of International to National. Suffice it to say that they adopted a set of rules which were in most respects along the lines of those of the National Electric Light Association. There were, however, some points of difference, and these rules have had several amendments which have been prepared and promulgated from time to time. Two months ago I had occasion to make definite inquiries throughout this country in regard to these electric lighting rules. I found that while the rules of the Underwriters National Electric Association are at the present time very generally adopted, yet there is a great difference in their promulgation and enforcement, and that is a difficulty which seemed to be an inevitable one in the early stages of the work, but will grow less and less pronounced as time goes on, because the insurance companies will have a better trained set of men. At the meeting of the National Electric Light Association I had some unofficial assurances which I was able to present to the committee, and they made a report which has been received with a great deal of favor in insurance circles. At the present time the affairs of the National Electric Underwriter's Association on the subject of these rules are in exceedingly good and competent hands. The chairman of the Electrical Committee is a member of this INSTITUTE, an electrician of accomplishments and standing, and one who in addition to his technical education has had a very extended practical experience in electric lighting and in telephony and telegraphy. All of these parties perceived the necessity of certain amendments and also the necessity of a unification of the whole set of rules, because this question of the function of these rules is not one which can be sub-divided and separated one part from another by any line of demarcation. It begins with the design and extends to the construction, the installation and the maintenance of all electrical apparatus of whatsoever kind or nature, whether it produces quantities of energy which can be converted into heat sufficient to cause a fire, or whether it pertains to the inherently harmless instruments, from battery circuits, but which may be and are in certain conditions a possible source of danger by reason of their exposure to the heavier currents used in lighting and in power. These questions are fully recognized and can be treated in only one way, and that is by a conference representing all of the various tributary interests. I am sure that the underwriters are alive to it and that they aim towards that end, because I judge from their representations to me to the extent to which I represent one of these interests of

electricity in this matter. I am looking forward to a conference which will occur in the immediate future representing, I do not care under what head, all of these various electrical interests and which will result in the unification of the electric lighting rules, and it is through that means and through that means alone, that such a result can be obtained. It should be conceded that it will take time for the training and development and selection of persons competent to enforce these rules adequately and justly.

THE CHAIRMAN:—The importance of this subject seems to demand that it be referred to a committee. We have a letter here received from one of our members who is ill. The Secretary will please read it.

THE SECRETARY:—This letter is from Mr. Fremont Wilson, a gentleman who I think has been referred to this evening. I will read an extract referring to the subject:

"If Prof. Anthony's paper is discussed, I hope it will be deemed of enough importance to have a committee of five appointed and a resolution passed, and a letter sent to the New York Board of Fire Underwriters, requesting the privilege of the audience of our committee to appear before the New York Board in relation to the non-observance of standard rules, etc., and to prove to the representatives of the New York Board the injury they are doing to the electric light and power interests throughout the country, by the peculiar methods that have been in vogue for the last two or three years.

THE CHAIRMAN:—What action will the INSTITUTE take upon this letter of Mr. Wilson?

MR. HOLMES:—If this committee, which it is recommended be appointed, is to simply consider what is advisable and appear before the Board of Fire Underwriters, I am in favor of it's appointment. But I am not altogether clear, as the resolution is phrased, that the committee will not be formed with instructions. I am in favor of such a committee.

THE CHAIRMAN:—It is proposed to refer the whole subject to this committee for action and report to the INSTITUTE.

MR. HAMMER:—I would like to suggest as it has been stated here to-night, that the matter is already in the hands of the National Electric Light Association and that their committee will extend an invitation to the INSTITUTE OF ELECTRICAL ENGINEERS, as well as representatives of the other interests, and that the matter will then be taken up, not dealing with specific cases but with the whole thing in a broad gauge way. While we may move a little bit more slowly in that way, I think perhaps by joint action going about it thoroughly, we will accomplish more than by having the INSTITUTE refer the matter to a committee in the way proposed.

MR. MAILLOUX:—I agree with Mr. Hammer that the matter ought to receive more deliberation before we act. At the same time, I feel that there ought to be a committee representing the

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS on the subject. I also feel that further discussion ought to be had on the subject, I think that there are others, who would be present at another meeting perhaps, who would be able to contribute to the discussion. This subject is too important and it is of too much interest not only for the welfare of the society but for the individual welfare of its members, to be passed over lightly. So far as the appointment of a committee is concerned I would be willing to leave that to the Council. I think the Council is competent to appoint such a committee and to give it proper constitution, but I think the whole matter might be well laid over to the next meeting. I would make a motion to that effect. (Seconded).

THE CHAIRMAN:—If it be your minds that this discussion and the appointment of the committee be laid over till the next meeting of the INSTITUTE, please manifest it by saying aye—contrary no.

(The motion was carried and the meeting adjourned.)

DISCUSSION IN CHICAGO.

A meeting of the Western members of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS was held in the Electricity Lecture Room of Armour Institute, on Wednesday, April 17, 1895. The meeting was called to order by the Local Secretary, Mr. B. J. Arnold, with about sixty members and visitors present. Mr. A. S. Hibbard was elected Chairman for the evening.

The paper, on "Underwriters' Rules," by Professor William A. Anthony, was read in detail by Mr. Arnold.

MR. CLARK C. HASKINS:—The subject matter of the paper of Professor Anthony is one of very proper interest to all who are desirous of advancing the art of electrical construction. I trust that every member of this association feels similarly in that regard, and is ready to further the good cause in every reasonable manner.

I note what the Professor says about the object of all rules, as he states it:—

"1st—To secure a safe and permanent installation.

"2nd—To provide for the repair or renewal of conductors in case of failure."

I agree perfectly with the gentleman. The three R's of electrical line maintenance are removal, repair and renewal, and the more readily these functions can be performed, the better for the plant, the constructor and the owner. Time is the only test of electrical appliances, and especially is this true of insulation. The conduit system is comparatively new. The electrical fraternity has carried it through several stages or moltings, as has been suggested in the paper under discussion. In its first embryotic condition, it was assumed to be a perfect insulator, and capable of

thoroughly protecting a couple of dry cotton-covered conductors —ordinary magnet wires. It didn't do it. There were several serious faults found in it, both electrical and mechanical. A second molting, and it still failed to fill the requirements, and again there was a change. We are now experimenting with the latest, and let us hope, the perfect conduit.

The public is complaining at the advanced cost of proper installation. It is extremely difficult to make an ordinary consumer understand the hazard of a poorly constructed plant. "He knows," he says, "plenty of plants that have been running right along for years, not built any better than" the cheap one he is running, or the cheap one he wants to build, "and they have never felt the need of better construction." I have occasionally seen such an individual converted in an hour by an object lesson, when months of argument would have been lost on him. The teaching of the public in any new branch of practical education is difficult and slow. The reason for this is that it costs money if one listens to reason and adopts the best systems and methods—and when one individual is convinced, his lasting wants are at once supplied; but his next door neighbor has to be labored with equally patiently, and long. In this system of education the class consists of single individuals—there is but one scholar in the school, and he is as often at the foot as at the head of his class. Now, between experimenting for inventors and making converts of purchasers, the constructors and engineers will have their hands and heads busily employed for some years to come.

My idea of a conduit is simply a something in which electrical conductors can be run for:

1st—Mechanical protection against injury.

2nd—Ease of removal and replacement for any cause or purpose.

But, in considering the insulation of a wire to be placed in a conduit, the insulation of the latter must not be considered, while at the same time if the latter is lined with a good insulating material, the conduit is that much better, and the installation that much improved.

I think the case before us a plain one. If a solid covering tightly woven outside a conductor will permit of the removal of that conductor, and its replacement by another, then the covering becomes a conduit. Whether a wire which already shows 20 megohms insulation resistance is any the less a good wire for being mechanically covered by extra braiding is scarcely a debatable question; but it does look unreasonable for any Board of Underwriters to accept one such wire for any purpose, and deny the same endorsement for similarly constructed conductors which will bear up under the same tests.

I think the day will come sooner or later when this whole matter will be solved by either conduits everywhere through

buildings, or raceways constructed in the walls and ceilings, or even better, open work everywhere. I look upon the last as the acme of good construction, if it can be reasonably accomplished.

THE CHAIRMAN:—It will be of great interest to hear discussions on the various points which the paper brings out, and we should like to hear from as many on the subject as possible. We are fortunate in having with us to-night a representative of our own Underwriters' Board, whose work is directly in this line, and I would ask Mr. Merrill to enlighten us on this paper from his point of view.

MR. W. H. MERRILL, JR.:—I thank you, Mr. Chairman, for extending to me the privilege of speaking at this meeting.

I regret that the paper by Prof. Anthony does not bring out the useful criticisms and suggestions which I had hoped from its title that it might contain. I had expected to speak on behalf of the Underwriters in answer to criticisms which might be made of the National Code of Rules, which we have worked on from year to year for such a length of time, and which is now almost uniformly adopted by Underwriters' organizations and municipal departments throughout the country. Instead I find the paper starts with a brief sketch of the history of rule-making which I cannot agree is correct in the share of this work it attributes to the insurance interests, and devotes the remainder of its discussion to a certain resolution adopted by the electrical committee of one local board of Fire Underwriters. Discussion of either of these points will be of little benefit to either the electrical or the insurance interests of the country as a whole. Much good would result from an intelligent discussion of the National Code as promulgated by the National Board. If there is any organization outside of their own employees that the insurance interests should look to for technical information which would lead to the promulgation of more specific, comprehensive and equitable rules, that organization is certainly the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

I do not think I am exceeding my authority, in stating on behalf of the electrical committee of the Underwriters' National Electric Association, that that body would welcome any suggestions or criticisms members of your INSTITUTE can give us either collectively or individually.

Fair and disinterested intelligent discussion of the many technical points to be considered in framing any set of rules is the only way to arrive at the best results. You have men among you, splendidly trained specialists, who are undoubtedly more competent to deal with many of the problems presented than are our inspectors. No one man can master the wide field covered by the science. Yet the insurance inspector is sometimes criticised for not having performed this feat.

Underwriters, as a body, are too closely cognizant of the part electricity is playing in their loss reports, not to welcome any aid

that can be given them by the men who are responsible for the service electricity has rendered, and perhaps for some of the pranks it has played. Whenever any man among you judges it would be for his or your interests to help us in our endeavor to properly regulate practice within safe channels, I promise you that the national body will not refuse to cooperate with him as far as lies in its power through the promulgation of sensible amendments and extensions to, as well as interpretations of the National Code of Rules.

THE CHAIRMAN:—I am sure we are very much obliged to Mr. Merrill for his very interesting talk, coming from a point on which we are not generally posted. There is another view of which we have heard nothing as yet, which is very important, and that is the view of the wireman. It would be well for us in bringing all the light possible to bear on this paper, if we could hear something from one who is in the wiring business. We have with us this evening Mr. Arthur Frantzen, who is actively engaged in the wiring business, and I know that he can give us something that will be interesting as well as instructive to us.

MR. ARTHUR FRANTZEN:—My discussion on the Underwriters' Rules will bear more on a contractor's view of the rules rather than a technical one. Mr. Merrill, I believe, has cited very clearly what good construction embodies; yet there are many things contractors must contend with, that underwriters seem to overlook: one being that all the most of our customers care for is the result at the cheapest figure possible, and the unscrupulous contractor gets the job every time, installing his work according to his interpretation of the rules, which differ according to the standard of education of the reader. Should his conscience be too elastic, the next thing is to conceal the defective work, or subsidize the inspector (were such a thing possible), in order to have the work passed. It is not the rules that prevent poor construction, but rather the practical supervision and enforcement of the rules by the inspectors. A case in view, that I know of, will show what I mean by practical, and showing the necessity of having inspectors experienced wiremen.

A contractor installed open wiring on knobs for a motor, and as the proprietor was in a hurry for power, the contractor connected his meter loops together temporarily and left joints unsoldered or taped until the meter was installed. In the mean time, during the contractor's absence, the inspector calls and examines the work, when, Lo, behold! he finds a most flagrant violation of the rules, and proceeds to cut off the two joints for exhibit "A" and "B," and the poor contractor became 10 inches short on his meter loops. Now, had the inspector been a practical or experienced wireman, he could readily have understood the case without any explanation.

In conduit work we have various experiences, and find that the only case when it is used as a complete system of raceways is

in large office buildings or fine residences. The general public as a rule will not pay for so expensive an installation if they can possibly avoid it. As regards the various conduits in the market, I find that where the lights are all in a small district; circular loom or canvasite makes the best work on account of its flexibility, but for office building work, with long runs, brass armored conduit is preferable; but the conduit to install is the single tube system of iron armored conduit. It is the only conduit you can install, and go on a vacation and return to find everything perfectly intact. The only drawback is its cost, and yet the single tube iron armored system is practically as cheap as the double conduit system of brass armored.

Nevertheless, conduit at its best has many drawbacks, such as breakage, inflexibility and liability to injury, which requires constant watching. The class of construction that gives the best satisfaction at all times, if done well, is open knob or cleat wiring. Here you have something neat to inspect, if well done. It is always accessible, and therefore changes are easily made. Of course, this would never apply to residences or office buildings; but in such cases a combination of special ornamental picture molding and direct and short runs of conduit from same to outlets makes without a doubt the cheapest and most satisfactory wiring installation.

Trusting I have not wearied you with a rather irrelevant discussion of rules which prove too much for us, if interpreted differently from our worthy inspectors, I will close with the hope that our cause may be appreciated more fully by underwriters and the public in the near future.

MR. L. GUTMANN:—I am not a wire-man. However, in regard to installation work, would say, that I divide up partly with Prof. Anthony and partly with Mr. Haskins. I do not think that it is a good practice to have a wire tightly located in tubes. On the contrary there should be plenty of air space between the conductor and the tubes, which by preference should be iron gas pipes. The conductors should lie centrally and be held away from the armor tubes by non-combustible insulators.

We cannot make iron rules and predict a given style of installation work to be the best. While conduit wiring in many cases is the more substantial, the open wiring will have its advocates in many places; the main reason being that with the same security of insulation we have cheapness and accessibility.

For a general plan of wiring I would use one or two inch pipes for all conductors to be placed in a vertical position and going from floor to floor, while all horizontally placed conductors, including fuse blocks, etc., may be placed in brick channels with removable fronts, which channels may be easily concealed if placed in the cove of the cornices, or else form part of the cornice of a room or hall. I do not think it worth while to dwell on the point, that a braid should be an insulated tube, as we all

know that this is a fallacy on the surface of it; besides a braid cannot be a substitute for an armor, nor does it provide for the air space considered desirable between shell and conductor.

THE CHAIRMAN:—The paper itself is, of course, an immediate reference to what has been called an Attix wire or tube. If there is anyone here who has had experience with Attix wire and who can speak in its behalf, we should be pleased to hear from him.

A late ruling has passed on this form of wire against others, which might be readily made. It is interesting at this time, when we have presented to us this paper on underwriters' rules, to bring out the fact that the representatives of the Underwriters' Board and the various lines of business are coming closer together in their views. I realize it very much in my business, and I have no doubt that you gentlemen, who are putting in electric light wires, also find it so. We are finding that the representatives of the underwriters are going at the questions involved in better fashion, and I am sure that we shall soon find a better ground plan on which to meet underwriters.

In our telephone installations we are using greater care than ever before, and the work is in many ways getting to be more satisfactory. The use of trolley and power wires has brought up a condition of things in which overhead wires are often made to carry extraordinary currents. This has only been touched upon in this paper, but I think that, in closing our meeting, we may add what may be but an expression of opinion, though I think you will all endorse it, that the subject of underwriters' rules and the subject of what we may do with our wires influenced by currents which they are not supposed to carry, is one of much importance and is worthy of a great deal of thought and a great deal of work. It is to be hoped that the work, as it goes on, may be brought out, not only at these meetings, but especially at meetings of our representatives with the underwriters' representatives, so that we may not be working in the dark and doing our work over, or doubling it.

MR. B. J. ARNOLD:—In 1889, while in charge of the St. Louis office of the Thomson-Houston company, I was called upon to reconstruct the lighting plant of the Southern Hotel, which consisted of a 50-light T.-H. dynamo with fifty 2,000 C. P. lamps running in different parts of the building. The plant was originally installed by the T.-H. company, with underwriters' wire. This wire was run under the floors and fished through from one hole to another. The result was that it came in contact with the iron beams of the building in many places. These iron beams consisted of old railroad rails, out of which the hotel is built, as the proprietor was largely interested in a railroad which had recently relaid its tracks with heavier rails, and the old rails were utilized in the construction of his building. The wires were supposed not to touch the iron, but as the lights for some inexplainable reason would suddenly go out at times, and

start up again as suddenly as they went out, without the defect appearing to be in the dynamo, the conclusion seemed to be that as the building was infested with rats, they occasionally stepped on the wires and brought them in contact with the iron of the building, causing a momentary short-circuit. It was not only severe upon the rat, but upon the lighting service, and caused great dissatisfaction. The management of the building had become thoroughly disgusted and threatened to throw the plant out, as they had fooled with it for about three years. They sent our company word that, unless the thing was fixed, they would abandon the plant. After looking it over, I decided that the best was none too good in this case, and as I feared that with even the best insulation available, the rats might chew it off and bring the wire in contact with the iron beams again, I adopted the only conduit system that occurred to me, as follows:

We secured bamboo fish poles, cut them in lengths of about six feet each, bored out the pith and threaded them upon okonite wire, and wired the building throughout in this manner, started up the plant, and so far as I know there has never been the least difficulty with it from that time to this. The management were to have 60 days to test the plant in before paying for it, but they sent me a check in thirty days with a letter, saying they were satisfied.

I believe this is the first case of interior conduit on record, but as I was more interested in getting the plant to work satisfactorily than in any personal compensation, I did not think of patenting it or attempt to protect it, and relate the instance here as it seems applicable.

THE CHAIRMAN:—The paper and discussions have been of more than usual interest to us, as they seem to be so much in line with our daily work. I am sure that we are all very much obliged to the gentlemen who have kindly spoken to us this evening, and have given us their ideas on this subject. If there are no further remarks, a motion for adjournment is in order.

[Adjourned.]

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

New York, May 21st, 1895.

The Annual Meeting of the INSTITUTE was called to order by President Houston, at 8.10 P. M.

THE PRESIDENT:—The Secretary will read the minutes of the last stated meeting.

The Secretary read the minutes of the meeting of April 17th, and on motion of Mr. Mailloux they were accepted as read.

THE PRESIDENT:—Before asking the Secretary to read the minutes of the last Annual Meeting, having the boxes of ballots here, and as the counting of the ballots is a considerable task, we will now proceed to the election of tellers, or the Chair will appoint them, as you see fit. What is your pleasure?

MR. HAMBLET:—I move that they be appointed by the Chair.

[The motion was carried.]

The President appointed Messrs. Douglas Burnett and C. O. Mailloux as tellers.

THE PRESIDENT:—It is the duty of the Secretary to report the proceedings of Council for the year—a brief report. Mr. Secretary, you will please read the report of Council.

The Secretary presented the following report:

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

REPORT OF COUNCIL FOR THE YEAR ENDING APRIL 30TH, 1895.

As required by the Rules, the Council submits for the information of the membership a report of the work of the INSTITUTE during the past year.

The Council has held ten regular and one special meeting at which the average attendance has been eight.

The publication of the proceedings of the International Electrical Congress, which was undertaken by the INSTITUTE under a guarantee of four hundred subscribers at $3.00 each, was completed by the issuance of the volume in December last. An edition of one thousand copies was printed, the cost of which was $1,517.17. There have been sold to subscribers and dealers and furnished for review 520 copies from which has been realized $1,242.91. The amount of unpaid subscriptions is $174.00, leaving a present deficit of $100.26, represented by a stock of 480 books on hand.

The demand for the book continues and the sale of the 480 copies on hand will eventually yield a profit. The expense of the publication was in excess of the estimated cost of $1,200, part of which was due to special editorial and translation work.

In June a suggestion was made to Council in a communication from one of the members, that the office of the INSTITUTE be removed to a down-town location. A special committee was appointed to consider the question, and after a thorough examination into the relative advantages of different locations, rooms were secured in the Havemeyer Building, which have been occupied by the Secretary and used for Council meetings and library facilities since Nov. 19th, 1894. This change involved an additional expense in rent of $250,00 a year, as it was still necessary that the INSTITUTE meetings should be held elsewhere, and the auditorium of the House of the American Society of Mechanical Engineers, which had been used for four years, seemed the most desirable place for the purpose. The files of the electrical and mechanical journals in the new location have proved much more accessible for the use of members, while visitors from various parts of the country have found the rooms of the INSTITUTE convenient and useful.

Mr. Edward Caldwell, Local Honorary Secretary at Chicago, resigned his office in September, owing to his removal from that city to New York. After securing the opinions of members residing in Chicago or its immediate vicinity, Mr. Bion J. Arnold was appointed as his successor. Papers have been read at both the New York and Chicago meetings according to the plan adopted last year and with very satisfactory results.

In view of the general interest in the engineering work at Niagara Falls, it was suggested to the Council by the Sub-Committee on Papers and Meetings, that the next General Meeting be held at that place. As it was found that the work would not be sufficiently advanced in May, it was thought desirable that a later date should be fixed upon and June 18th was chosen. A committee was subsequently appointed with power to postpone it if necessary not later than July 1st.

A Council rule has existed for several years restricting the numbers of transfers from associate to full membership to five at each meeting. As the delay caused by this limit led to a considerable amount of correspondence and explanations, and on account of the number of applications constantly accumulating, the number was raised to ten, beginning March 20th.

The Board of Examiners also recommended the adoption of a rule requiring that candidates for transfer should reach the age of 27 years before their applications for transfer from associate to full membership would be considered. The adoption of this rule was deemed advisable, for the reason that the experience in electrical engineering considered essential could not ordinarily be attained before that age was reached. The action taken was also in accordance with the practice of similar societies in other branches of engineering.

The total membership at the close of last year's report was 800, classified as follows:

Honorary Members	3
Members	235
Associate Members	562
Total	800
Associate Members elected	186
Total	986

Total brought forward...		986
The following have resigned during the year:		
A. F. CHRISTMAS,	CHARLES LIEB,	
E. L. FRENCH,	F. WAYLAND-SMITH,	
ARTHUR L. HOOPES,	CHARLES A. BROWN,	
J. N. JAMES.		
Total resignations	7	
The following have died during the year:		
PROF. H. L. F. VON HELMHOLTZ,	JOHN C. GEORGE,	
RUDOLPH EICKEMEYER,	GEORGE B. SHAW,	
FRANKLIN P. LITTLE,	CHARLES M. PAUL,	
GEORGE M. PHELPS.		
Total deaths	7	
Dropped from the roll on account of non-payment of dues	16	
Elected, but failed to qualify	12	42
		944
Leaving a total membership of 944 on April 30th, (a net gain of 144,) classified as follows:		
Honorary Members		2
Members		281
Associate Members		661
		944

The reports of the Secretary and of the Treasurer show in detail the financial affairs of the Institute at the close of the fiscal year:

SECRETARY'S BALANCE SHEET.

FOR THE FISCAL YEAR ENDING APRIL 30, 1895.

Dr.		*Cr.*	
To balance from 1893	$ 44 90	By cash to Treasurer	$10,602 22
Receipts for the year	10,572 52	Secretary's Balance on hand	15 20
	10,617 42		$10,617 42

ITEMIZED STATEMENT OF RECEIPTS AND EXPENSES OF THE INSTITUTE.

FOR FISCAL YEAR ENDING APRIL 30, 1895.

GENERAL ACCOUNT.

Receipts.		*Expenses.*	
Treasurer's Balance from previous year	$407 54	Office Expenses	$ 66 93
Secretary's " " " "	44 90	Office Fixtures	86 30
Sundry Receipts	29 95	Telegrams and Express	19 52
Entrance Fees	900 00	Stenography and Typewriting	712 50
Life Membership (James Lyman)	100 00	Stationary and Miscellaneous Printing	577 83
Past Dues	324 27	Postage	335 80
Current Dues	6,947 08	Messenger Service	55 43
Advance Dues	80 00	Salary Account	2,402 81
Electrotypes Sold	71 78	Meeting Expenses	332 21
Transactions Sold	506 90	Rent of Office and Auditorium	1,200 00
Transactions Subscribers	212 75	Engraving and Electrotyping	630 21
Advertising	219 32	Publishing Transactions	2,665 66
Received for Binding Transactions	27 50	Binding Transactions and Periodicals	33 85
" " Badges	219 10	Paid for Badges	204 13
" " Certificates	42 10	Paid for Certificates	19 75
" " Congress-Book	891 81	World's Fair Expenses	10 43
[The amount of Advance Subscriptions in last year's report was $351.10.]		Congress Book	1,470 19
		Secretary's Balance to next year	13 20
		Treasurer's " " " "	186 28
Total,	$11,024 96	Total,	$11,024 96

The outstanding current bills against the Institute, April 30, amounted to	$ 2511 29
Due from members	1847 88
Due from advertisers and others	205 71

The net gain in membership exceeds that of the previous year by seventeen. It will be seen, therefore, that while the financial stringency which has prevailed during the year has not checked the growth of membership, it has interfered with collections, and a large proportion of the amount due from members, is on account of lack of employment or loss of business. A fair proportion of this will, no doubt be paid, even should the present condition of business continue.

Respectfully submitted for the Council,

RALPH W. POPE,
Secretary.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

New York, May 18th, 1895.

TREASURER'S REPORT.

FROM MAY 1, 1884 TO MAY 1, 1895.

GEORGE A. HAMILTON, TREASURER, in account with

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Dr.

Balance from May 1. 1894	$ 407 54	
Received from Secretary, May 1, 1894 to May 1, 1895	10,602 22	$11,009 76

Cr.

Payments from May 1, 1894 to May 1, 1895, on warrants from Secretary, Nos. 522 to 617, inclusive	$ 10,823 48	
Balance to new account	186 28	$11,009 76
Balance on hand, General Fund, May 1, 1895		186 28

BUILDING FUND.

Balance as per last report	$ 850 00	
Interest accrued to May 1, 1895, 3 per cent., to May 14, 1892 and 2 per cent. thereafter	72 48	$922 48

Cash book and warrants herewith for audit. Vouchers are in the hands of the Secretary, to whom they are returned for filing after payment.

GEORGE A. HAMILTON,
Treasurer.

New York, May 18th, 1895.

THE PRESIDENT:—The Secretary has a minute to report from the Council relative to the date of the Niagara meeting.

SECRETARY POPE:—At the meeting of Council this afternoon

it was decided to hold the General Meeting appointed to be held at Niagara Falls, on the dates of June 25th to 28th inclusive.

At the meeting of Council this afternoon the following associate members were elected:

Name.	Address.	Endorsed by
ANDREWS, WILLIAM C	Student Electrical Engineering, Columbia College; residence, 162 Hicks St, Brooklyn, N. Y.	F. B. Crocker. Max Osterberg. W. H. Freedman.
BEAMES, CLARE F.	Electrical Engineer, Gen'l Elec. Co., Schenectady, N. Y., residence, 63 W. 131st St., N. Y. City.	C. P. Steinmetz. Ernst J. Berg. H. G. Reist.
CANFIELD, MYRON E.	Western Electric Co.; residence, 404 W. 44th St., N. Y. City.	E. S. Keefer. H. F. Albright. Geo. A. Hamilton.
DEWAR, JOHN THOMAS	Electrical Expert, Western Electric Co.; residence, 33 Rue Bouewijns, Antwerp, Belgium.	A. G. Inrig. F. R. Welles. Geo. B. Compagnie.
GHARKY, WILLIAM DAVID	Sup't Underground Cable Construction and Maintenance, Philadelphia Traction Co.; residence, Windsor Hotel, Philadelphia, Pa.	Minford Levis. F. Uhlenhaut, Jr. E. G. Willyoung.
HENDERSON, HENRY BANKS	Graduate Student, Cornell University; residence, 76 E. Buffalo St., Ithaca, N. Y.	Ernest Merritt. Harris J. Ryan. Fred'k Bedell.
HOGENTOREN, SYDNEY	Electrical Expert, The Varley Duplex Magnet Co.; residence, 1617 Avenue B, N. Y. City.	R. Varley, Jr. T. W. Varley. R. W. Pope.
JACKSON, THEODORE K.	Assistant to Sup't, Hyde Park Elec. Light and Power Co.; residence, 137 56th St., Chicago, Ill.	B. J. Arnold. L. K. Comstock. R. W. Pope.
ROLLER, FRANK W.	Electrical Engineer, with J. C. Machado, 203 Broadway, N. Y.; residence, 515 Clinton Avenue, Brooklyn, N. Y.	W. A. Anthony. E. P. Thompson. E. A. Merrill.
SIMPSON, ALEXANDER B.	Estimator, N. Y. Electrical Equipment Co., N. Y. City; residence, 125 2nd Place, Brooklyn, N. Y.	Aug Noll. E. A. Merrill. W. A. Anthony.
WILCOX, NORMAN T.	Manager and Electrician, Seneca Light and Power Co., Seneca Falls, N. Y.	A. L. Rohrer. Geo. F. Curtiss. A. G. Mercer.

Total, 11.

The following associate members were transferred to full membership, their applications having been approved by the Board of Examiners:

ROMAINE CALLENDER,	Electrician, Decker Building, New York City.
J. DAY FLACK,	Electrical Engineer, 252 West 85th St., New York City.
F. R. COLVIN,	President, Interior Telephone Co., 203 Broadway, New York City.
RUSSELL ROBB,	with Stone & Webster, 4 Post Office Square, Boston.
V. M. BERTHOLD,	American Bell Telephone, 125 Milk St., Boston.
HERBERT LLOYD,	General Manager, Electrical Engineer and Chemist, The Electric Storage Battery Co., Drexel Building, Philadelphia, Pa.
HARRY HARTWELL BLADES,	General Superintendent, The Detroit Motor Co., 1343 Cass Avenue, Detroit, Mich.

Total, 7.

The Secretary also read the following communication:

New York, May 21st, 1895.

To the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS:

Gentlemen:—At the Annual Meeting of the INSTITUTE held in New York City, May 15th, 1891, It was voted that $500.00 from the surplus of that year, together with the $350.00 constituting the Building Fund be invested, and that Treasurer George M. Phelps and Secretary Ralph W. Pope be appointed Trustees to take charge of the matter.

This amount was placed by the Trustees as a special deposit with the Mercantile Trust Co., and with accumulated interest now amounts to $922.48, as appears in the Treasurer's report.

By reason of the death of Mr. Phelps, there remains but one trustee, and it appears proper, under the circumstances, that this meeting should take action regarding the vacancy.

Yours truly,

RALPH W. POPE, Secretary.

THE PRESIDENT:—Gentlemen, what action will you take on the recommendation concerning the vacancy in the trustees caused by the death of Mr. Phelps.

MR. KENNELLY:—Mr. Chairman, I move that Mr. George A. Hamilton be appointed trustee.

[The motion was carried.]

THE PRESIDENT:—Will Professor Crocker please read the report of the Committee on the Indexing of Electrical Literature?

MR. HAMBLET:—Mr. President, before proceeding with the reading of that report I would suggest that the usual committee be appointed for auditing the accounts of the Treasurer and Secretary for the past year.

The chair appointed Messrs. Hamblet and Petty as an Auditing Committee.

PROFESSOR CROCKER:—Mr. President and Gentlemen: this report was submitted to the Council at its meeting this afternoon and was referred by the Council to the Annual Meeting of the INSTITUTE. It is a preliminary report of the Committee on Indexing Electrical Literature. It is not final in any sense whatever, and is simply given for the information of the INSTITUTE, and will be followed later by a more full report.

Professor Crocker then read the following report:

PRELIMINARY REPORT

OF THE COMMITTEE ON INDEXING ELECTRICAL LITERATURE TO THE COUNCIL OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the regular meeting of the Council held December 20th, 1894, a Committee on Indexing Electrical Literature was appointed, consisting of Prof. G. D. Shepardson, Prof. W. M. Stine, Mr. A. E. Kennelly, Mr. E. Caldwell, and Prof. F. B. Crocker, Chairman.

In view of the fact that it was practically impossible to get all the members of the Committee together, a circular letter was sent to each member, requesting answers to certain questions. The questions and answers of the five members of the Committee are given below.

QUESTION 1. Is it advisable for the INSTITUTE to actually undertake the indexing of electrical literature?

The answers received substantially agree that while it is not incumbent upon the INSTITUTE to undertake the work, at the same time it is very desirable, and the INSTITUTE seems to be the best if not the only body to carry on the work permanently and authoritatively. The only question in regard to the INSTITUTE'S undertaking this matter is that of ways and means, which is considered under question 4.

QUESTION 2. Should the Index cover the past or current literature or both?

A. Four out of five members were of the belief that the past literature is the more important, and should be cared for first. The other member thought it advisable to attempt only current literature. The reason why past literature was considered more important is that current literature is fairly well covered by several indexes now being published.

(For example by the *Electrical World*, *Electric Power*, the Association of Engineering Societies and the *Fortschritte der Elektrotechnik*.)

QUESTION 3. Should the Index contain digest or notes, or merely titles of references?

A. All five answers agreed that the Index should contain brief notes as to the character or scope of the article.

This would seem almost essential, since a single line of description would save the looking up of probably seven-eighths of the possible references.

QUESTION 4. What means, particularly financial, can be devised to carry on the work of indexing?

A. The entire matter, of course, turns upon the answer to this important question and the Committee believes that the expense will be quite heavy, and probably much more than the INSTITUTE could bear with its present means. Two members of the Committee who are particularly qualified to estimate the cost of this work put the probable expense at $30,000 and $16,000 respectively. This includes the expense of compilation and publication of a reasonably complete index up to date. Two members of the Committee proposed raising the dues five dollars or two dollars and fifty cents, respectively, to meet the expenses. The other members doubt the propriety of this measure, as it would force many members of the INSTITUTE to pay for something which they do not require or use. The alternative plan would be to sell the Index by subscription to libraries and individuals, but it is doubtful if the number subscribed for would be sufficient to cover the large expense which the work would involve. The subscription, however, might be supplemented by the INSTITUTE bearing a certain amount of the expense, or by the cooperation of other societies in this country or abroad, or even by governmental aid—the United States Patent Office or the Smithsonian Institution. For instance, one member suggested that considerable expense might be saved by assigning a portion of the work to competent volunteers; for example, the indexing of a certain periodical could be assigned to an individual or an electrical school, without taxing their time very heavily, and it is probable that quite a fraction of the work could be done in this way. All the members of the Committee believe that an editor and two or three assistants would have to give their entire time to this work to make it successful—in fact, the salaries of these men would be the chief item of expense, since it is estimated by three members of the Committee that from three to four years would be required for the work.

Thus it will be seen that the problem resolves itself into a simple question of sufficient means to carry on the work. From all other points of view, it seems to be the unanimous opinion of the Committee, and of others with whom it has consulted, that an index of electrical literature is very desirable and could be successfully and permanently carried on. Its value at the present time would be very great and in years to come it would be of incalculable benefit to to the electrical profession.

This report is merely given for the information of the INSTITUTE since your Committee does not consider that the time has arrived to formulate or propose definite recommendations in this matter. The Committee prefers to wait for further consideration of the question and would gladly welcome any suggestions from the members of the INSTITUTE.

F. B. CROCKER, Chairman.

THE PRESIDENT:—The committee has asked for suggestions on the part of the INSTITUTE. Those suggestions are now in order. I understand that this is only a preliminary report.

PROF. CROCKER:—Yes, sir. It is proposed, if possible, to hold a committee meeting at Niagara Falls, where we hope to get all the members together. It will be an opportunity that has not occurred so far, and is not likely to occur again, and we may be able as the result of such a meeting to formulate some definite plan.

THE PRESIDENT:—If the INSTITUTE can see its way, financially, to undertake work of this kind, it will certainly be greatly to the benefit of our particular study—electricity. It has occurred to me that it might be possible to get the English society, the Institution of Electrical Engineers, to join with us in the expense; or, a suggestion which the chairman of the committee threw out, might be utilized, not so much in the way of getting an appropriation from the government for carrying out this difficult work, but in the way of obtaining the aid of some army or naval officers. I remember that the indexing of the very extensive Journal of the Franklin Institute was largely done by a government officer, who was detailed by the United States government for the purpose. This is work that a skilled, educated man can do thoroughly, particularly if he be not hurried. I think it is quite possible that many an army or a navy man might be quite pleased to undertake work of this kind. The committee would receive any recommendations from the members of the INSTITUTE. If there are none, we will pass on to the next matter on the programme.

It was decided at our last meeting that Prof. Anthony's interesting paper on "Underwriters' Rules," which for lack of time could not receive the full discussion that its merits and importance demanded, should come up for discussion this evening. I will therefore ask that the discussion be opened by Prof. William L. Puffer of the Massachusetts Institute of Technology, and the subject will then be open for discussion by any member who wishes to take part.

Discussion.

Prof. Wm. L. Puffer:—I must confess that I was somewhat surprised when I read the notice announcing to the members that I was to open the discussion on this paper, especially as it was a paper that I did not hear in the first place, and the discussion of which, taking place either here or at Chicago, I have not very carefully read. I looked over the proofs this morning but somewhat hastily. I have been very much interested in this general matter of insurance rules for quite a number of years, and especially the last year or so. I think I may say that I fully agree with Prof. Anthony in nearly all the remarks that he made about the subject of his paper, which branched off, I think, towards the close, on to a particular form of insulation of wire, which was termed, I believe, a tube. I agree with him most decidedly that the mere fact of putting a braid, no matter how good it may be, over a wire good or bad, does not in any sense constitute a tube from which the wire may be removed. I take the ground that the presence of a mechanical covering on the outside of a wire is a very desirable thing as increasing the life of the insulation, and in that way to be encouraged; but not in the sense of a tube, and it should not be used as in ordinary work. In my own mind I have had the notion for quite a while that any electric wire ought to be mechanically protected if that wire was in a position where there was the most remote possibility that there could be any interference with it; and I remember the first occasion when I had to consider the matter seriously was in the laying out of a lighting system in the iron stack of a large library, in which case it seemed desirable, after looking the ground over, to recommend—and this, if I remember correctly, was just before the days of the first tube—to recommend that in that library, rubber covered wires should be used, and that two wires should be put together and pulled into common iron gas pipe which should be cut with due care in removing the fins which are left by the cutter. I believe to-day that really is the best position for wires subject to mechanical injury, for you cannot easily hurt anything inside of an iron pipe unless you have an enormous amount of power at command which is not likely in the average place. Of course when we come to consider the iron pipe we must draw a distinction, I think, between the use of alternating currents and direct currents, for I know that if we have alternating current work, and if we attempt to put a single conductor in an iron pipe there will be difficulty. It will cost too much copper on account of the false drop we get due to the presence of iron. Also there is the liability of trouble due to the mere hysteresis loss of iron undergoing the various cycles of magnetization. So that it would seem desirable, to me at least, to twist the wires rather than to lay them parallel in the same pipe. As even a twisted pair of wires in an iron pipe will have a false drop, it is much better, in my mind, to put those wires

in the form of concentric cables. But I do not believe in the usual statement that those two wires should be insulated by something that practically is no insulation at all, that is, a layer of ordinary cotton threads. For I believe if insulation is worth having at all, we ought to insulate between the wires, aiming to keep the wires apart rather than afford an opportunity for the wires to come together and break down the system. With the wires in pairs in an iron tube, if the fuses are properly proportioned, there will be no trouble from burning holes in the pipe itself, except in the case of very large conductors. Under those conditions there is, of course, the possibility of melting tube, wire and everything else.

In the discussion of this paper there was what I might call a general uprising, in which the insurance rules and insurance people and things of that sort were treated rather harshly. But you must consider that the insurance people have a very wide field. They have to meet many considerations on every side, the consideration of the various contractors, the cheap Johns, and the man who is paying the bill, and taking it all together it is not an easy row to hoe. I do not agree with them in all points. I think there have been mistakes in the insurance rules and that there are mistakes in them to-day—such, for instance, as to what a safety fuse is. The statement, as it rests now, I think is something like this: "The safety fuse shall be stamped with the number of amperes it will carry indefinitely without heating," or something to that effect. Well, we know that a good sized piece of copper might be stamped 2 amperes, and we could safely guarantee it against heating with that current. That is one of the little loop-holes which are in the rules. Of course it should read "That it should just melt, etc." The Associated Factory Mutual Insurance Companies of New England have seen fit in their Inspection Department to take up the general question of inspecting electric risks, because they have had trouble; there have been fires started under conditions where they should not; it is true they have not cost very much money up to the present time, but they may cost a great deal. Upon looking over the style of risks of these companies and seeing that they really were selected risks, or mills generally—no stores, no show-windows, no houses, no fire-traps, but mills in which the æsthetic side of wiring plays no part at all, it seemed best to me and to the department at that time to modify the rules, which we took in the main from the pamphlet issued by the Underwriters' National Electric Association, and giving due credit in our books for what we took, then modifying, changing and leaving out a great many rules which in our judgment did not apply to the mutual risks. It seems to me that the National rules as they stand are not really what we might call up to date. They take no account of some of the newer forms of transmission, the newer dangers and the newer precautions which should be taken. While in

general I believe in sticking to one set of rules throughout the whole country, it seemed best to make certain variations. I may say that the Inspection Department is a department maintained by, I believe, twenty insurance companies—mutuals—for mutual aid in preparation of drawings for their plans, sprinkler layouts and general engineering questions, and also to lay out and maintain a very carefully planned set of inspection routes, keeping men travelling around the different mills all the time, each mill being visited, I believe, about four times a year. The work of the department is in general advisory, and it aims to meet the mill men in a friendly manner, to meet the contractors in a friendly manner, and to do all possible good without stirring up any bad feelings. The scheme of rules as we got them out is arranged in some such way as this: In our introduction we admit the uniformity of standards as a desirable thing, and then we have to depart from it on account of inability to agree, which is the general reason for want of uniformity. The general plan of our rules is something like this: We have divided them into classes, the first class being generators as a whole; the second class being electric motors as a whole, and then comes arc lighting as a whole; then low potential systems; then high potential systems for power transmission in general, and there is where the danger lies now, I think, mainly. Then there is the electric railway class, the storage battery, the welding, and the foreign or private wires as we call them. We have taken great care to give due credit in our book to all the rules which we have taken bodily from the Underwriters' rules as issued previous to the 1st of January. Any changes which we have made, even to changes of grammatical expression, and any new rules, have been marked very carefully with a large block letter to distinguish them from the rules which they may have replaced. We then say in large print on the page opposite the first page of rules, that these rules are to be considered as carefully drawn specifications indicating what we believe at the present time to be the best form of construction for mill work, and advising that all contracts for new work have a copy of the rules bound in as a part of the contract, and then we go on and give our rules. Under each rule we have written very carefully a description or explanation of what is meant by that rule, for in our work we find that we can very often convince a man and lead him to our belief by telling him the reason why, when we cannot do it by telling him that he must. Under the head of grounding lightning arresters, for instance, we describe how to do it and why certain things are bad. And so under everything. We explain as well as we possibly can and get out what seems to be to us a good set of rules. The only objection which we have met with up to the present time—I expect to hear a number before the evening is over, however—has been due to only one rule which we have modified, and that rule which we have modified is the rule about sockets and lamps.

Now the regulation rule says, that the shell of the lamp socket shall be insulated from the circuit. In addition to that we say "nor should any exposed part of the lamp base be a part of the circuit," for you know well enough that every portable lamp and every drop-lamp cord is handled by everybody—Tom, Dick and Harry, in the basement, in the attic, in the cotton room where there is loose stuff, down in the well or where it is wet, and there is no reason, in my mind, why the exposed part of the lamp base should not be insulated from the circuit; for there is no use in carefully insulating the holder and the socket and the guard ring for holding the shades, and then put in a 50 C. P. lamp or even a 16 C. P. with a great shell outside and leaving that in connection with the circuit with all the dangers that abound when there are portable exposed parts of the circuit, or exposed parts of the circuit in such places as to be within reach of everybody.

There is another matter too, in which we have departed, and it is the subject that I wanted to bring up, especially as my share of the discussion of this general paper on insurance rules, and that is the question of the carrying capacity of wires. Under that head there is a great deal that can be said. You remember that in the old insurance rules previous to the 10th of January, when the changes were made, the carrying capacity table was based on the experiments of Mr. Kennelly some years ago, which experiments, we must all admit, were very carefully carried out, having a scientific basis and depending on practical measurements.—just what we want when we fall back on any particular thing as a standard—something that we can back up and defend. Now about the last part of December, I believe, and in the official papers which came out about the 10th of January, the Underwriters National Electric Association issued a set of ratings—two of them, in fact, one for concealed and one for open work. The concealed work table has been increased 25 per cent. over the old table, which was based on Mr. Kennelly's figures, and the open work, meaning cleated work overhead, has been increased 75 per cent. Now, at that time, we could not see our way clear to adopting all those changes, for it was quite plain to my mind at that time, that we were running altogether too close to the point where the insulation of the wire would be very seriously injured, and perhaps in this connection I ought to say what the table used by us at that time was based upon. It was based on a recommendation make by a large and thoroughly scientific committee of the English Institution of Electrical Engineers, who reported that in their opinion no wire should ever be heated to a point higher than 150° F. In their experience they had learned that rubber and rubber compounds on an average began to disintegrate at 150° F. We have taken some trouble to find out whether or not the average American wire would come under this same classification, and we find that the average statement is about the same. That means that the average rubber wire can

be trusted only up to 150° F., or a rise of 75° over the average temperature of the atmosphere. Then, taking that point as the ultimate limit, the English engineers recommended that the wire should not carry over one-half that current which will heat the wire up to 150° F., thus providing for a safety factor of two; this one-half current will produce a rise of about 19° F., which of course is very low. Now, with respect to these new ratings the increase of 25 per cent. and the increase of 75 per cent., there is in the official announcement which I have here, no authority for the increase, no excuse, no reason, no scientific basis for the table. It is simply given as an arbitrary table, and therefore just as good or just as bad as any other arbitrary table.

At that time I had some experiments carried on simply to test the correctness of my opinion that it was not desirable to heat wires so much as permitted by the new table. We keep the old rating for the present, but I do not say that we shall not change that rating. I do not say that if the proposed conference between the various interests sees fit to recommend, after due deliberation, one of the ratings, we should not adopt it. But at present we do not want to do so, for we think that that rating may possibly be changed when the danger of it is properly brought out. I then went to work looking up as many data as I could find and I plotted them on a sheet of paper which I have here. I have Prof. Forbes' tables for bare wire and for covered wire. They do not agree with anything else that I have been able to get. I had also plotted Mr. Kennelly's work for bare wire, black wire and concealed wire; also some experiments of our own, and from them reached the general conclusion that Professor Forbes' tables, which are based on scientific experiments, not made on wires, but on something else; are not correct. They do not give the proper carrying capacity for the wire at that particular temperature.

Now, as to the methods which I took to find out certain results, I suggested to one of our young men at the Institute, for a thesis, that it would be advisable to carry on some very interesting experiments from this point of view; we obtained seventy-five samples of wire, which we put through a careful test. The object of the test was to find out what strength of current passing through those wires for, say ten or fifteen minutes, would raise the temperature of the wire up to some definite point which we would readily recognize without measurement of the resistance or any guess-work. The first end point that was used was when a very small drop of water, inserted through a small hole in the insulation and put in contact with the copper would just boil; that was the first point. The next point was, when the slightest trace of visible smoke appeared. There were those two points. The seventy-five samples of wire were put through that particular test in this way; we took a 500-volt alternating circuit, connected it through a reactive coil to a welding coil. In the

welding coil secondary we put the wire under test in series with a suitable ammeter and very slowly increased the current until the points were found. If the boiling point, which generally came first was reached too quickly, the current was reduced. The aim was to find the current which would just be sufficient when long continued, to give the indication. The wire was used in five foot lengths, and bent into a horizontal loop nearly circular. The room was as free from drafts as could be, and such care was taken that the results are as close as the rather uncertain end point will allow. Now, before showing you the curves, I want to refer to one thing which I have never seen pointed out:—it seems to me that in wiring, as in all engineering work, we ought to allow a safety factor. A bridge builder who in his calculations only allowed for the amount of weight he was

FIG. 1.—Arrangement of Apparatus for Heating Tests of Insulation.

going to carry over a bridge, would not be the man we would trust to build the Brooklyn bridge. We would want a man who would build a bridge that would stand not only the weight of the bridge cars but of the people in them, not only that of the people in them in ordinary times, but of the crowds who would be there in the case of a blockade, and we would want a margin beyond that. So in wires we want a margin—a margin over something—the only question that can be asked is over what? The reason for this margin is due to the fact that we cannot trust our fuses. Suppose we could trust to a fuse—we know that if we have a shunt motor, and start one of these great ventilating fans, that we have to use for a short time a great deal more current than the rated current for that motor, before we get the fan up to speed. We know too, that if our main line voltage is

fluctuating, we have to put in a big fuse to take care of the fluctuations of the current. That means that the wire which presumably has been put in on the rating of the motor, has got to stand whatever can pass through the fuse that is used in practice. I say if that is the case, the rating table of the wires should have a safety factor, or else there should be some other way of getting the larger wire, as for example by specifying that the wire used should carry twice as much as the motors are rated for, or better still, carry the amount that the fuse will carry that we have to use in commercial operation. The curves I have are in rather a small shape for a room as large as this. Here (Fig. 2) is a sheet of paper. On it I have plotted the curves of Mr. Kennelly; one curve being the experimental curve, the double of which currents heat the wire up to 150° F. Along with that I have plotted the mathematical curve which Mr. Kennelly finds fits the experimental quite closely, and from which he calculated the safe carrying capacity of wire which has been taken as a basis for insurance work. The insurance table is rather inaccurate however, the values being given only to the nearest five amperes. In the table I have given the proper value as taken from the experimental curve and also the rating as adopted until January 10. Then I have plotted the double of that curve which is, of course, for a total rise of 75° F. These plots are for paneled wires. In order to show the difference between paneled wires and wires in the air, I am obliged to go to Mr. Kennelly's results and take from them his experiments on bright copper and black copper; then plotting them, in order to avoid confusion, at 80° C., I have plotted 80° C. rise with bright copper, black copper and paneled wire; the lower curve representing bright copper, the upper bare copper, the middle, paneled wire. The three curves keep together fairly well, showing that if we should take the panel wire curve as a basis for the rating in general we would not do any very great injustice to either the black copper or the bright copper. So I have simply taken it for granted that the paneled wire curve is correct enough for a basis.

The seventy-five samples which we tested up to the smoking point and the boiling point are plotted on this paper, and they give us this top curve. That curve represents the average of the smoking points of all sorts of wires that you can think of. There is thin underwriters', there is thick underwriters,' there is black line wire, thick and thin, there is rubber covered, thick and thin—all sorts. They all smoke just about at the same point. It does not make any difference whether you have the white underwriters' or the very heavy covered wire; if you watch carefully you will see smoke at just about the same current for the same sized wire. So you will agree with me, I think, that we may speak of the smoking point as a definite thing. The smoking point and the boiling point correspond at the smaller values and differ slightly at the upper values—5 or 10 per cent.

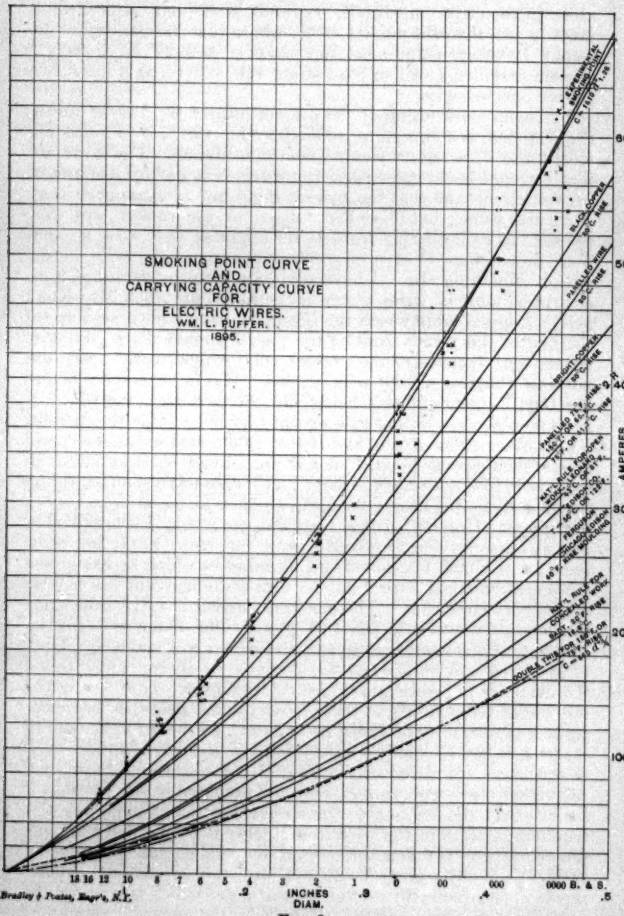

SMOKING POINT CURVE
AND
CARRYING CAPACITY CURVE
FOR
ELECTRIC WIRES.
WM. L. PUFFER.
1895.
AMPERES
100
200
300
400
500
600
18 16 12 10 8 7 6 5 4 3 2 1 0 00 000 0000 B. & S.
.2 .3 .4 .5
INCHES DIAM.
Bradley & Pratt, Engr's, N.Y.

FIG. 2.

Now as regards the safety factor—if we think of the injury to the insulating cover of our wire—and there is nothing else provided in the rules but rubber covered wire—our safety limit must be less than the point 150° F. where that rubber begins to spoil. Its safety point must not be over the 75° F. or 40° C. rise curve which I will call the safety valve curve, as it were, for rubber covered wire.

The open work rating of the present insurance rules—I mean the National, is a curve immediately under this 75° F. and almost up to it, no safety factor worth considering. I will admit that it would be all right possibly, provided it was for a constant current circuit and that the current could not increase over that particular value; but if we are obliged to use rubber wire for the sake of its insulating features we might as well save it, and if we do not want to save the rubber covering of the wire, let us put on something else. I have advised a factor of safety of 2 in our rating table of wires which is nothing else than Mr. Kennelly's original table which the insurance people have used up to the first of this year. And by the way, I should show you the 25 per cent. increase of the present rule which really rests on nothing whatever except arbitrariness. It is in here—here being the 150° F. point and this being the 25 per cent. increase. I have no objection to that rule except that if I double the current I heat the wire too much, and if that rule rested on some experimental data equally good, I should not object to it at all, and even now I do not object, except that it does not rest on anything particularly. We have nothing to go back to.

Professor Holman, of the Institute, to whom I showed this plot as I was leaving to take the train for New York, has sent me a letter which I received this morning in which he has given me a mathematical expression for this smoking point curve—he says is very close to it. The smoking current is 1,610 times the diameter of the wire to the 1.28 power, the diameter being in inches. The current then in amperes which will make any kind of insulated wire smoke can be calculated by taking 1,610 times the diameter in inches raised to the 1.28 power. Now the limiting rise of temperature of these observations made in ordinary air at a temperature of about 20 to 25° C. in about 80° C., and if we look at Mr. Kennelly's eighty degrees rise curves there is a discrepancy. Mr. Kennelly measured resistance and from that calculated the temperature. I am not prepared so say whether I believe that the resistance measurement actually expresses the true temperature of the wire itself. May it not be that the middle of the wire is much hotter than the outside, and consequently Mr. Kennelly's error be in one direction while our experiments must necessarily rest on an end point which is a little bit hotter and therefore giving an error in the opposite direction. Probably this is the reason for the discrepancy. If you will notice again you will see that, practically speaking, the original

rating multiplied by 2 is the danger point of rubber. Twice that again is the point at which the rubber or any other insulation begins to smoke. Now it seems to me that a factor of safety of 4 is not too great; nor a factor of safety of 2 up to the point where you know you are going to spoil your wire insulation altogether.

It might not be uninteresting to read the table. I will read first the size of wire, Brown & Sharpe, then the ratings according to the experimental determination, then the ordinary insurance rule, then the 150 degrees, and then the smoke.

TABLE OF LIMITING CURRENTS FOR B. & S. GAUGE.

B. & S.	1	2	3	4
0000	180	175	360	630
000	149	145	298	519
00	123	120	246	438
0	103	100	206	372
1	86	85	172	319
2	72	70	144	273
3	60	60	120	237
4	52	50	104	207
5	45	45	90	178
6	39	35	78	155
7	34	30	68	134
8	29	25	58	127
10	23	20	46	87
12	17	15	33	65
14	13	10	25	48

No. 1. This column is taken from the published curves of Mr. Kennelly's experiments and express as nearly as could be taken from his curves those currents whose double would heat the wire up to the 150° F. point or 75° F. rise.

No. 2. This is the usual rating given in insurance tables before January 10th and is a rough approximation to the mathematical curve of Mr. Kennelly's.

No. 3. Taken also from Mr. Kennelly's curves and is a table of currents producing 75° F. rise or the danger point of rubber coverings.

No. 4. This is the table of smoking points of all kinds of insulations.

There is another point I want to bring up in connection with the general matter of insurance rules, and that is a question which I think is becoming quite important—and please understand that I do not stand as an alarmist in any way. I believe that electric lighting is a pretty safe thing. In connection with this insurance work I have seen some plants so bad that I do not see how they could run them at all. I have seen a plant so bad, and so fuseless in the proper places that when the engineer was asked if there was any trouble about running the dynamos, he said that sometimes the belts got to slipping a good deal, but if they got very bad he would hold them on with a stick for a little while, and then it would be all right again. The great spread of alternating current work is introducing danger, especially in mill work, where there are very high potential systems in use. The high potential is coming in the shape of transmitted current from a long distance, for use in the mill for light and power. For power work, of course, we can easily make it as safe as any power. But for lighting work, I think that the ordinary installation is a source of consid-

erable danger which can be entirely removed by a device which I am a little afraid to suggest, although I believe in it thoroughly. I believe that where a transformer is used, receiving energy, say at three, four or five thousand volts, and transmitting the energy over a mill for lighting circuits at comparatively low voltages, that it is introducing a serious danger. Of course I admit, with everybody else, that converter insulation never breaks down. Nevertheless, suppose it did happen, and there are those who say it does now and then, we have the high voltages distributed over a hundred different circuits containing lamps and sockets designed for only the small voltage. Of course we know that any employee giving the system the slightest touch would have a shock even if the insulation was perfect, due to the electro-static capacity. I think the insurance rules ought to introduce another factor, and that is safety to life as well as safety from fire. I think there is something of an insurance nature in the demoralization of a fireman when he realizes that if he touches a wire he is likely to get an unpleasant sort of shock. Such a fireman is not half as good in putting out a fire as a man who will wade right in. Now, here is my suggestion: thoroughly ground the middle of your secondary wire. If you do that, your trouble all disappears. I look on it as the choice of two evils; I will take the lesser evil, and that lesser evil is grounding the middle of the secondary, putting a lesser strain on the insulation than by a ground either side, rendering it impossible for the high voltage to go over your mill, and then no one can get a greater shock from any part of the service than the voltage of the plant itself between the wire and ground. Suppose you have a 100-volt plant: if you ground in the middle, there is 50 volts alternating which is not a very serious matter. If you have a 3-wire transformer, it is nothing but 110 volts. If this is done, the electro-static charge element entirely disappears. You have no fear whatever of grasping your secondary wire at any particular point, and I must admit that I always take hold of a wire that I know to come from a transformer with very considerable dread; and that element would then disappear. The fire danger, I think, is comparatively small, and the fear of shocks in the minds of the firemen will instantly disappear. For in mill work, you know, the firemen are right around the premises at work, and they know just what is going to happen when they touch those wires, and from experience they will learn that there is nothing going to happen.

I think, gentlemen, I have taken altogether too much time under the pretense of opening the discussion on another man's paper by almost introducing one of my own. But I should be very glad to add anything that I can which I may have left out, or supply any information that I possess in this general matter that I have brought out and which I wish to have fully discussed, and especially the grounding of the secondary of transformers, which I believe most decidedly to be the proper thing.

MR. A. E. KENNELLY:—Mr. President and gentlemen, I did not intend to say anything so early in the proceedings; but as there seems to be an unwillingness on the part of many present to bring forward their own remarks, I want to fill in the opportunity at least.

The broad question as to the desirability of having insurance rules revised, is, I think, very evident, since there seem to be so many different sets of rules in existence, and these not only differ in detail, but also radically, so that the rules by which a particular installation shall pass in one case or by one company, will not permit that same installation to pass or be admitted under the regulations of another company. The question as to how far this INSTITUTE ought to enter into an arrangement whereby such conformity of action can be obtained, is a little more difficult to determine. On the one hand it seems clear that from all commercial questions at least, the INSTITUTE should be careful to keep aloof, because a danger we all know exists that if the INSTITUTE enters into a question of endorsing a particular wire of Mr. A—. or the particular way of putting in a wire of Mr. B—. that there would be a continual demand that the INSTITUTE shall endorse the particular wires of Mr. X., Mr. Y. and Mr. Z. But in a case of this kind where injustice appears to be possible to a number of manufacturers, and to a number of persons who desire to make and install good work, it seems desirable that the INSTITUTE should at least lend a hand in settling a very difficult and very important matter. While of course, it is easy to put one's finger upon the weak points in various rules as we see them, yet I think we may perhaps be doing scant justice to bodies that have been doing a great deal of good work in the past; I mean these different insurance boards and the work that has been done by their advisers. I think there can be no doubt that if these insurance bodies with their rules and their inspectors had not been at work in the past, that electric lighting would have fallen into a great deal more discredit, and the art would have been much less advanced than it is at present. I think we owe therefore, a great deal of good to their efforts, even although their rules may be capable of improvement in detailed particulars. I think it is very important that any such system of rules should not state anywhere what good manufacturing should be. I maintain that every man should keep to his own business, and it is not the business of the fire inspectors or the fire insurance board to say what good electrical engineering, or good electrical manufacturing, or good electrical installation may be. The business of that board or those inspectors is to say what dangerous or false installation and work may be; and any system of rules, therefore, which should be arranged as a uniform system throughout the country should be careful to state what should not be done and not to try to define what should be done. If they do that, there will be far less

danger of having to modify their rules every few months, as electrical methods multiply and change. The electrical manufacturer, contractor or engineer does not desire to state what fire hazard is, or its limitations, or its commercial capabilities. His duty is to endeavor to make the plant he has in hand as good as it can be made under the circumstances. Insurance rules would go beyond their natural limits altogether should they attempt to say what ought to be used, instead of simply saying what ought not to be used.

In regard to the detail question of the safe carrying capacity of wires, I think it is only fair to mention that Professor Forbes, when he tabulated such results as he possessed a good many years ago—I think it was about 1885—merely took such information, such experimental data as existed at that time, and put them into tabular form. He did not in any way declare that such data were reliable, but simply assuming them to be reliable gave the results to which those data pointed; and consequently the fact that in conformity with more recent developments, the tables that he prepared are not perfectly accurate, does not in any way detract from the merit of Professor Forbes' work. In fact he pointed out a great many things at that time which were and still are valuable, and which were new and important.

The question of how much margin should be left in different wires is an important one, because it always raises a question of economy; that is to say, the man who wants to put in a wire as cheaply as possible, wants naturally to put in as small a wire as shall be permitted to him under the rules; whereas, the man who has to take the fire risk wants to have that wire as large as possible, so that under no conceivable conditions the wire may become too hot. Therefore there must always be a conflict and a clash of opinion between those two representatives. When a large wire is put in, I mean a main or a sub-main, that large wire does not, it would seem, require to carry such a large excess of current as a small wire. That is to say, some accident may happen on a small wire by which an unduly large current may pass through it, or a motor may be on that wire which may require an unduly large current; whereas, all over a building a number of such accidents will not conspire, and therefore, a large main does not, I think, require so large a margin of safety as a small wire. But I agree with Professor Puffer that a margin of safety is desirable, and that we should not work up to the safety limit in putting in wire, particularly a small wire. The safety limit of a wire is I think we will all agree, a wire which you can hold in the hand without discomfort. When a wire is so hot that you cannot hold it without either having a very thick epidermis or else a remarkable degree of Spartan equanimity, that wire is at the limit of safety. I think this temperature is reached by about 50 per cent. excess of currents over those given in the original table of Insurance Rules.

I think then that a committee might be formed by the INSTITUTE, which should have the power to arrange some plan by which a general conformity of rules should be met all over the North American continent, to specify what bad practice should be, and what should be avoided, and that by such a plan we shall gain not only in simplicity but in security, and at the same time the manufacturer and the man who is putting in a plant shall not be harassed and hampered by needless complications.

THE PRESIDENT:—I see Mr. Woodbury is here. We would be pleased to hear from him upon this subject.

MR. C. J. H. WOODBURY:—Mr. President: The treatment by the speaker of the evening of the carrying capacity of wires is one which has a great deal of interest, and the ratio used in his factor of safety is one which I think deserves very careful attention. A factor of safety is an empirical multiplier, whose necessity in the mechanics of engineering is for the most part due to the variation between the hypothesis upon which the modulus of rupture is based, and the results of the precedents furnished by experience. Now, if a similar method of procedure will furnish a short cut to correct results in the treatment of the problems of the safe conductivity of wires, it will furnish a desirable innovation in many instances.

The suggestion of the last speaker is one which is somewhat attractive, and yet I believe that there is on the part of others something under way in that line in which when the details are presented, I think it will be found that arrangements have already been made for affiliating with the INSTITUTE OF ELECTRICAL ENGINEERS for the advice, cooperation and skill which they will be enabled to give.

The question is sometimes asked as to how far the underwriters should go as a matter of business policy on the promulgation of these insurance rules, which apply to the hazard of electricity, which is one of many hazards. An insurance policy is a contract of indemnity under conditions which are stated on that policy, and which must be construed according to the laws and decisions of the various states having jurisdiction. It may be considered that if a body of underwriters go beyond a certain point in the specifications of electric wiring or any one thing, they also assume responsibilities which may not have been contemplated in the original policy, and therefore there is a phase to this question outside or beyond that which is purely electrical or purely commercial, and that is the insurance side. I believe that it is through the insurance companies that the questions pertaining to the hazards of the transmission of large quantities of electrical energy, and their abatement, has been brought before the manufacturers and operators of electric plants, and that with the various opinions on the subject there is no doubt but that in the immediate future the results will be codified in rules which will be equitable and satisfactory to all of the various elements of the community which are interested in this subject.

PROF. W. A. ANTHONY:—As I stated at the last meeting it was my object in reading that paper to provoke a discussion upon this matter and not so much to bring any particular aspect of it before the meeting. I felt that it was important that the electrical engineers should consider in some way the question of the insurance rules. I had no particular plan in mind. I did not suppose that the electrical engineers would go to work to frame rules for installations, but I wished to provoke a discussion which should show just where the engineering fraternity stood in this matter, and I am glad that so much has been done. This matter that has been brought before us to-night on the safe carrying capacity of wires alone, shows the importance of having this work done by engineers who understand the subject and who know just what the work means. Professor Puffer has brought together all the various experiments on the subject, has given us a number of new experiments of his own, and given us something on the safe carrying capacity of wires that we never had before. The fact that the insurance rules have been changed in this respect, without any warrant, without referring to any authority, seemingly entirely arbitrarily, enforces exactly the idea that I had in mind that it is the engineers who should decide upon such matters as these, and not the insurance companies. It seems to me that when such changes as these are made, the engineer should be consulted upon those changes, and I hope that some plan will be devised by which the engineers may have a voice in the matter.

The points that have been brought up here to-night are exceedingly important ones. The margin that should be allowed is a very important consideration, because safety fuses are uncertain in their action. The blowing of a safety fuse always takes time, and if a very large current is at once thrown upon a wire, a safety fuse may last long enough, before it blows, to allow the wire to become very highly heated, and this is especially the case where large wires are concerned, and where we are depending upon large safety fuses. I do not know that I quite clearly see the force of the remark of Mr. Kennelly on that point, that a large wire does not need the same margin of safety as a small one, because if we depend on safety fuses to protect a large wire, a large safety fuse takes so very much longer time to blow than a smaller one. If a current appears that is sufficient to injure the larger wire it is apt to remain upon that wire just so much longer time, unless an automatic magnetic break is used for cutting the current off. I can see, of course, that the large wire may not be as liable to be subject to a large current, because we may not have the combination of circumstances to occasion the great excess of current on the large wire. But that other point, that when we attempt to protect a large wire by a large fuse, that safety fuse may fail to blow and may carry the current for a long time over the wire, it seems to me makes it just as im-

portant that the large wire should have as large a factor of safety as the small one.

MR. W. J. HAMMER:—At the last meeting I referred to the proposed call by the National Electrical Light Association for a joint meeting of the different organizations. I have here a list of those to whom it is proposed by that committee to extend the invitation. Although the formal invitation has not yet been extended, it will be very shortly, and assurances have already been given informally by a number of those parties that they will co-operate. It is proposed that this meeting should probably be held towards the latter part of September.

DR. C. T. HUTCHINSON:—I suggest that this discussion be ended. This is an entirely foreign matter.

THE PRESIDENT:—I think this has a bearing on the subject. The question under discussion was Professor Anthony's paper and also to see what action the INSTITUTE would take in pursuance thereof.

MR. W. J. HAMMER:—The organizations to whom it has been suggested that invitations be sent are, THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, The Underwriter's Association, the American Street Railway Association, the American Bell Telephone Company, the National Fire Chief's Association, the Western Union and Postal Telegraph Companies, the American Institute of Architects, the Inspection Department of the Associated Mutual Insurance Companies of Boston, and there are also several others which are under the consideration of the committee. It is also proposed to extend at that time a general invitation to any one interested either in insurance matters or in electrical installation throughout the country to send in to that meeting any objections or suggestions which they might have with respect to any of the rules which are at present being promulgated throughout the country. It is proposed that meeting should be held toward the latter part of September. It is hoped that such questions as Professor Puffer has brought up here to-night as to the carrying capacity of wires will receive very careful consideration.

Since the last meeting a prominent officer in the insurance interests sent me a letter in answer to some correspondence in which he said he was afraid there was considerable feeling among the insurance interests as to the attitude of the INSTITUTE as shown by our last meeting, and I think that if the gentleman had been present at the last meeting he would probably have felt differently about it. I do not think the position taken then by the members of the INSTITUTE was for anything but the general advancement of the subject and securing of the very best methods in construction and operation of electric work.

MR. J. I. AYER:—The relations of the insurance interests to the electrical interests in regard to wiring rules have been more or less strained for a number of years, in fact ever since the insurance people organized a department of electrical inspection,

and it has been difficult to reconcile the differences and get harmonious action between the bodies representing the two interests —the insurance and the electric. That most of the trouble has been brought about by misapprehension there is no doubt, and by the lack of concerted action on the part of the electrical people. The National Electric Light Association representing the central station interests of the country has endeavored to effect harmonious relations and bring about the object which is now being sought, not only by the electrical people but I think, to some extent by the insurance people; that is a general code of rules which will suit all interests and which will perhaps be the result of the work of all interests; and I think it is only proper to emphasize the remarks made by Mr. Kennelly and Mr. Hammer in expressing the sentiments of the INSTITUTE so that there may not be a misconstruction put on this discussion by the insurance people of the country, but that they may understand the desire of the INSTITUTE is to harmonize with them—is not to oppose them but to work in harmony with them, and produce a universal set of rules. The insurance people in protecting their interests have apparently trodden on our toes, perhaps usurped our prerogatives as engineers, and this has been brought about wholly by the neglect of engineers to take care of their own interests.

In relation to the suggestion of Professor Puffer to ground the middle of the secondary coil of the transformer where high potential alternating currents are transformed and used for lighting and other purposes in mills—several years ago when our transformers at the ordinary pressures (1,000 volts alternating) were not as good as they are now, and would break down, some of us were much worried and had to suffer a great deal of anxiety by reason of the dangers people were subjected to by using these inferior devices which happily have disappeared. At that time I had occasion to design a protecting device, which, I think, would cover the difficulties he meets with, and that was an automatic switch which was operated by two solenoids, or either one of two, to open the main line of the secondary at the entrance of the building whenever a high potential current might get on the secondary wire. The solenoids were of sufficiently high resistance to prevent the leakage of but very few watts—they were connected directly across the mains, and the wire between was grounded—but with any excessive potential difference sufficient current would flow to actuate the magnets and open the circuit. The switch in opening could easily be arranged to permanently ground the secondary leads from the transformer, and leave the building cut out. These meet the difficulty without grounding the middle wire of the transformer, to which there are objections.

MR. FREMONT WILSON:—Professor Puffer's paper has interested me greatly. In regard to his criticism as to the factor of safety on motor wires differing from the factor of safety on

electric light wires, my experience has been that there should be a great difference in the factor of safety. I would suggest that as we have a guest here this evening, a gentleman who has probably had more experience with motor service in this city at least, than any of the other members, that he be invited to give us his experience in regard to the factor of safety of motor lines, as compared to the factor of safety on electric light lines. I refer to Mr. Arthur Williams of the Edison company.

THE PRESIDENT:—The INSTITUTE will be pleased to hear from Mr. Williams.

MR. ARTHUR WILLIAMS:—After listening with much pleasure to the paper of Professor Puffer and the remarks which have been made, I really think that to present what I have learned in my own experience in a comprehensible form would require more time than it would be proper for me to take. I am hardly prepared to make any remarks that would interest the INSTITUTE, and therefore ask to be excused.

THE PRESIDENT:—I believe, gentlemen, that there is no other matter on our programme. I will encourage you by informing you of the fact that the envelopes are almost opened.

MR. C. O. MAILLOUX:—Some of the delay has been due to the fact that I have been feeling rather restive as the result of trying to follow the interesting discussion and do my work as teller at the same time. My excuse is that I am perhaps as much interested in this discussion as any member of the INSTITUTE, because my practice as an engineer brings me into as intimate contact with these rules as perhaps any other member of the INSTITUTE in this section and in various other parts of the country. Although I was unable to follow the whole discourse this evening because of my duties here as one of the tellers of this election, yet I followed it with as much as I could lend of attention. I am very glad that there has been the amount of expression of opinion that we have received this evening. I am glad to see that we are apparently aroused to the necessity of some action. I spoke with considerable feeling on the matter at the last meeting, and I perhaps could not do more at this session. I do feel, however, that I must reiterate the sentiment which I expressed, which is, that we ought not to be placed in the position of being dictated to in this matter in regard to what is proper, furthermore the rules of insurance inspection ought not to be such as to hamper progress in electrical installation. I know that in many instances in my experience I have found it impossible to introduce the reforms and improvements which were calculated to greatly enhance the character and value of the installation, and therefore, I feel strongly that there should be an end to all such methods that tend to retard the progress of electrical work, and make us go back to prehistoric systems.

DR. C. T. HUTCHINSON:—It occurs to me that there would be a good deal of difficulty in telling just what margin of safety

should be used in different cases. A factor of safety of 2 for which the double current brings the wire up to an unpleasantly warm point for the hand only, would be large, I should think, in many cases.

I did not altogether understand the reason for grounding the middle of the secondary. I should like very much if Prof. Puffer would explain it a little further when he speaks again.

Mr. Kennelly suggests changing the form of the rules entirely and substituting a series of "don'ts" for "do's." This seems to me fundamentally wrong, for if you formulate rules saying you shall not do certain things, you leave it entirely to the discretion of the inspector, in each case as to what shall be done. This would be one prohibited and many possible, some of which would be a great deal worse than the one proscribed. I should think that would open the door wide to the worst kind of work. I trust that Professor Puffer's paper will be published.

Mr. Mailloux:—Speaking from experience, I can say that the remarks made by the last speaker, if I understand him rightly, have a great deal of force. I do not think that it would be wise for any set of rules to undertake to go too clearly into what we ought to do. I think it would give us more latitude to do what we would like to do by placing the limitations in the form of negations, that is placing the limitations as to what we must not do. I think those limitations must be made as few as consistent with the conditions of absolute safety and general good work. Let the expert or specialist engineer attend to the rest. One of these limitations ought to be, for example, that Attix wire shall not be used except in a conduit for concealed work.

Dr. C. T. Hutchinson:—I cannot take the credit given me by Mr. Mailloux, this was Mr. Kennelly's suggestion. Mine is just the reverse.

The President:—Gentlemen, as I understand it, the question is whether it would be the part of wisdom for the American Institute of Electrical Engineers to prepare a code of rules for the safe installation of electric plants, which could in any way be called the American Institute of Electrical Engineers' Rules. I do not think that such work is our function. It seems to me that by so doing we would then put ourselves in the position in which we claim that the Board of Fire Underwriters are. We can criticise their rules; that is perfectly proper. But I do not think we want to make rules of our own. It is, however, intolerable for engineers to be put in the position of being told what is good engineering. This, I think, is something to which we should decidedly object, and I would be glad to see the Institute join with the parties referred to in a consideration of a code of rules. I would be sorry to see the Institute attempt to formulate a set of rules distinctively their own. I doubt very much if such rules would be accepted by the Board of Fire Underwriters, and any attempt to introduce them would make confusion worse confounded.

PROFESSOR PUFFER:—There are two or three things I have noted as the various members have spoken. First, about the INSTITUTE rules—I think if the INSTITUTE attempts to go into the matter of rules it will come out in about the same way that the English Institution did. The English Institution attempted to go into rules, and met with the Phœnix Fire Office. The Phœnix Office was willing that the Institution should use any number of their rules they saw fit and modify them, provided it gave credit for the original rules which it declined to do, and the whole matter dropped through.

In regard to the matter of Prof. Forbes' experiments, I did not wish in any way to criticise the value of his work at that very early date when very few of us knew anything about electricity whatever. But I want to call attention to the fact that taken in the light of to-day his data were not right and rules based on those data could not be correct. Some error crept in, as it is evident, in all of his tables.

I would say, in connection with the inspection department, the element of judgment is admitted. We believe most decidedly in judgment, and at any time any contractor feels, and can show us that there is reason for believing that the modification of a rule or the adoption of a different method would be better, we are perfectly willing to allow and grant permission to do that very thing, which we would not allow in another case. For example we would admit, so far as fire is concerned, almost anything in an underground vault, where there was nothing but stone walls to burn, but if that same underground vault was a powder magazine we would not admit it. There, judgment is allowed. It is not allowed in the ordinary rules.

I would also say that I have a number of carrying capacity tables issued by different people, and I have striking illustrations of tables brought out by different authors and not properly credited, or at least that seems to be the inference, and in general the tables can be divided into two groups; one allowing a margin of safety of 1.5 to 2, and the other allowing scarcely any at all.

Some speaker has objected to the statement that rubber wire at the temperature of 150° F. is a dangerous thing. I did not intend to say that rubber wire at that temperature was a dangerous thing. What I say is this—if it is desirable to put the rubber tube on the wire, it is put there for some special reason that calls for rubber. Then if you do go to work and heat the wire inside the rubber to a point that would spoil that rubber, you are doing a wrong thing. While I do not object to spoiling the insulation in cases where the insulation is of no particular use, I should rather not have the insulation put there in the first place, for, of course we all know that rubber wire sufficiently overheated is a very dangerous thing. I have made a good many experiments on the actual burning of wires, and it is remarkable how rubber wire will act when suitably heated.

About the margin of safety of big wires I agree with the speaker—I think it was Professor Anthony—that larger wires ought to have the same margin as smaller ones, for the danger comes when there is trouble in the system. For example, with a great dynamo in a plant distributing through great feeders, the danger comes when there is a short-circuit on the mains, of such a resistance due to the length of the arc that the current which may not be sufficient to blow the main fuses, will be sufficient to greatly overheat the insulation of the wires or even soften it.

About grounding the secondary—the reasons I believe in it are, first, to get rid of electro-static troubles; of course, that would be admitted, I think, anyway. Secondly, I have made a great many experiments on grounded transformers, and I have read with a great deal of attention the accounts of accidents that have happened through breaking down of transformers. I remember one where a transformer broke down during a sleet storm in the winter, simply due to the leakage of water into the case, and it was discovered accidentally and I immediately went there. I succeeded in burning 16 50-volt lamps in series between any lamp cord and the tin gutter of the green-house. At night, when it got cold, the ground entirely disappeared, and there was no inconvenience experienced. In the morning when the thaw came on again, we had the same trouble. These things could not positively happen with the middle of the secondary dead grounded, which fact in itself, is almost reason enough for the grounding. The worst thing that can happen is to blow a primary fuse.

In regard to the carrying capacity of the wire on motor load, I think personally that the carrying capacity on the motor load ought to have a greater margin if anything than on a lamp load, for the man that runs the motor is going to put in a fuse big enough not to trouble him under running conditions. I can, perhaps, best illustrate by a particular example, where a very big motor, several hundred horse power, was put in, supposed to take 60 amperes under full load. The wiring was figured on insurance rules for 60 amperes. It was found necessary on account of the starting current to use 180-ampere fuses. Now that wire calculated for 60 amperes was evidently protected, if such we can call it, by 180-ampere fuses. So that you will see that in that case there is quite a large demand on the safety factor of the rating of that particular wire. I know of a great many cases where motors at times are so heavily overloaded that they take in current three times their rating; that is, being rated for one, the current is often as great as 3. If the wire is selected for the rated current of the motor on the insurance rating of the wire, it is evidently carrying about 200 per cent. more than it ought to carry, and the protecting fuse is one that will allow at least 200 per cent. increase of current over the wire previous to the melting of the fuse itself.

[After the discussion of Prof. Anthony's paper, the business of the annual meeting proceeded as follows:]

THE PRESIDENT:—Are the auditors ready to report?

MR. HAMBLET:—I would say that the committee find the figures of the reports of the Secretary and Treasurer correct. We have endorsed the Treasurer's book in regular form, but will prepare the regular report and place it on file.

On motion the report was accepted.

The President appointed Dr. Cary T. Hutchinson and Mr. W. J. Hammer to assist in counting the ballots, and a recess was taken, subject to the call of the chair.

At 11 50 P. M., Vice-President Hamblet called the meeting to order, when the following report was submitted by the tellers Douglass Burnett and C. O. Mailloux and their assistants, W. J. Hammer and C. T. Hutchinson.

TELLERS' REPORT.

Total Votes Cast..... .....392.

FOR PRESIDENT.

Louis Duncan	334	T. A. Edison	1
F. B. Crocker	24	H. Ward Leonard	1
E. Thomson	8	F. A. Pickernell	1
A. E. Kennelly	8	Nikola Tesla	1
E. L. Nichols	6	C. P. Steinmetz	1
C. E. Emery	2	Joseph Wetzler	1
T. D. Lockwood	2	Blank	1
W. A. Anthony	1		

Total.....392

FOR VICE-PRESIDENTS.

A. S. Hibbard	343	C. R. Cross	3
M. I. Pupin	333	F. W. Jones	3
W. F. C. Hasson	307	E. W. Rice, Jr.	3
C. P. Steinmetz	36	A. L. Rohrer	3
H. J. Ryan	21	Samuel Sheldon	3
A. E. Kennelly	19	A. J. Wurts	3
E. L. Nichols	11	W. S. Barstow	2
Alfred S. Brown	9	T. C. Martin	2
F. A. Pickernell	8	Jos. Wetzler	2
W. J. Hammer	7	W. A. Anthony	1
C. O. Mailloux	7	Frederick Bedell	1
W. M. Stine	6	Louis Bell	1
D. C. Jackson	5	O. T. Crosby	1
L. B. Stillwell	5	Louis Duncan	1
G. A. Hamilton	4	C. E. Emery	1
T. D. Lockwood	4	H. A. Foster	1
C. F. Scott	4	F. L. Pope	1
O. B. Shallenberger	4	G. D. Shepardson	1
W. D. Weaver	4	J. G. White	1
Gilbert Wilkes	3		

FOR MANAGERS.

C. F. Scott	328	J. J. Carty	2
B. J. Arnold	322	C. L. Clarke	2
Carl Hering	322	Alex. Macfarlane	2
C. T. Hutchinson	292	Wm. Maver, Jr.	2
H. A. Foster	32	E. W. Rice, Jr.	2
T. C. Martin	31	H. A. Rowland	2
Samuel Sheldon	31	W. S. Barstow	1
F. A. Pickernell	21	P. Benjamin	1
Louis Bell	17	E. Caldwell	1
F. Bedell	15	C. Cuttriss	1
Wm. Stanley	15	F. DeLand	1
R. H. Pierce	13	W. E. Geyer	1
A. V. Abbott	10	C. D. Haskins	1
G. S. Dunn	8	E. J. Houston	1
H. V. Hayes	8	J. W. Lattig	1
D. C. Jackson	8	H. Ward Leonard	1
C. O. Mailloux	7	Aug. Noll	1
Jas. I. Ayer	5	H. F. Parshall	1
C. C. Haskins	5	F. L. Pope	1
J. W. Lieb, Jr.	5	L. Stieringer	1
Jos. Wetzler	5	W. M. Stine	1
F. B. Crocker	4	L. B. Stillwell	1
S. D. Greene	4	Leonard Waldo	1
R. O. Heinrich	4	W. D. Weaver	1
P. Lange	4	J. G. White	1
A. L. Rohrer	4	A. J. Wurts	1
W. A. Anthony	3	Townsend Wolcott	1
Albert Schmid	3		

FOR TREASURER.

George M. Phelps	227	W. D. Weaver	4
George A. Hamilton	129	Joseph Wetzler	2
W. J. Hammer	16	T. C. Martin	1
F. B. Crocker	10		

Total.....389

(Signed),

DOUGLASS BURNETT,
C. O. MAILLOUX,
Tellers.

New York, May 21st, 1895.

On motion of Mr. Mailloux, it was voted that the ballots cast for Mr. Phelps be declared void, and that the plurality of the remaining votes be accepted as determining the choice for Treasurer.

The chair then announced the election of the officers named in the report having the greatest number of votes, including George A. Hamilton, Treasurer.

[Adjourned.]

"The work contains much valuable information, which is here published for the first time, and owing to the simultaneous sessions of the different sections of the Congress, many of the papers are new, even to those who attended the sessions."—*Electric Power.*

Now Ready

PROCEEDINGS

OF THE

International Electrical Congress

AT CHICAGO, 1893.

Published by the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

PRICE, $3.00.

This volume is the only complete and authorized edition of the proceedings of the most important electrical gathering ever held in America

It contains the official report of the

CHAMBER OF DELEGATES,

and the frontispiece is a reproduction of the only group negative of its members in existence.

The papers read before the Congress are fully illustrated, and with the verbatim discussions, form a book of great historical and technical value. It contains 522 pages, and its publication was under the supervision of a special Committee of the Congress, and a similar Committee appointed by the Institute.

Among the contributors and participants in discussions appear the most distinguished names known in electrical science.

The book will be sent by express or mail prepaid on receipt of the price strictly in advance.

Cloth, $3.00.
Paper uncut, $3.00.
Half Morocco Cloth Sides, $4.25.

Address,

American nstitute of Electrical Engineers,
26 CORTLANDT ST.,

Telephone 2199 Cortlandt. **NEW YORK CITY.**

"A full history of this interesting and important congress of electricians, and a publication of the many papers presented to it by some of the foremost electrical engineers of the world."—*Engineering News.*

"The report of the Chicago Electrical Congress constitutes a volume which has a distinct value, not only as a record of what was accomplished at that important meeting, but as a memento of a gathering such as will probably not be brought together for many years to come."—*Electrical Engineer.*

"Of very great interest and value to all who have to do with electricity."—*American Machinist.*

"The proceedings of the INSTITUTE have acquired so high standing that any of their publications may be pronounced a sine qua non in every scientific library. As a matter of course, the present work represents the highest grade of publication in its own line. We may note that this volume is largely given up to alternating current work, and thereby the tendency of the day is indicated."—*Scientific American.*

EDWARD P. THOMPSON, M. E.

PROF. WM. A. ANTHONY,

TEMPLE COURT, · · NEW YORK.

United States and Foreign **Patents**, Electrical Specifications, Expert Advice and Testimony.

American Electrical Works,

Manufacturers of

BARE & INSULATED ELECTRIC WIRE, CABLES, &c.

Providence, - R. I.

DAY'S KERITE

Highest Grade of Insulation for

Electric Wires and Cables.

—GRANTED:—

Two Highest Awards World's Fair, Chicago, Ill., 1893.

W. R. BRIXEY,

SOLE MANUFACTURER,

203 Broadway, - New York.

J. E. HAM,

General Agent.

EXPERIMENTAL AND MODELWORK,

Electrical Apparatus and Fine Machinery,

Special Tools, Patterns, Gear Cutting, Specialties, Repairs, Etc.

E. V. BAILLARD, 106 Liberty St., N. Y.

TRANSACTIONS WANTED.

I have orders on file for volumes 3 and 4 (1886 and 1887) Transactions A. I. E. E., wanted by new members and libraries to complete their sets. The following prices will be paid for copies in good order.

Volume 3, - - - - - $2.

Volume 4, - - - - - - $3.

Address, RALPH W. POPE, Secretrry.

McINTOSH, SEYMOUR & CO.

AUBURN, N. Y.

—BUILDERS OF—

Engines FOR ALL Electrical Purposes.

THE AMERICAN BELL TELEPHONE COMPANY,

125 MILK STREET, BOSTON, MASS.

This company owns Letters-Patent No. 463,569, granted to Emile Berliner November 17, 1891, for a combined telegraph and telephone, covering all forms of microphone transmitters or contact telephones.

Webster's International Dictionary.

The New "Unabridged."

Standard of the U. S. Supreme Court, of the U. S. Gov't Printing Office, and of nearly all the Schoolbooks. Warmly commended by every State Superintendent of Schools.

The One Great Standard Authority.

Hon. D. J. BREWER, Justice of U. S. Supreme Court, writes: "I commend it to all as the one great standard authority."

G. & C. Merriam Co., Publishers,
Springfield, Mass., U. S. A.

☞Send for free prospectus containing specimen pages, etc.
☞Do not buy cheap photographic reprints of ancient editions.

COPPER WIRE TABLE.

This table gives the WEIGHTS, LENGTHS and RESISTANCES of cool, warm, and hot wires of

MATTHIESSEN'S STANDARD CONDUCTIVITY,

for both Brown and Sharpe (A. W. G.) and Birmingham Wire Gauges (B. W. G.)

It was prepared by the Institute Committee on Units and Standards personally revised by the individual members of the Committee, and issued with the October, 1893, number of the TRANSACTIONS, forming a part of Volume X.

Mailed separately, price 10 cents.

RALPH W. POPE, Secretary,
26 Cortlandt Street,
New York City.

Contents of Vol. XII. 1895, as far as Published.

CATALOGUE OF MEMBERSHIP. ON THE UNITS OF LIGHT AND RADIATION. B Alexander Macfarlane. THE BEST METAL FOR FIELD MAGNET FRAMES. (Illustrated.) By Alton D. Adams. No. 1, January. RAIL-BONDING, AND ITS BEARING ON ELECTROLYTIC CORROSION. (Illustrated.) Communicat on by Geo. P. Low. NOTES ON RECENT ELECTRICAL ENGINEERING DEVELOPMENT IN FRANCE AND ENGLAND. By H. Ward Leonard of New York. No. 2, February. A METHOD FOR PREVENTING ARMATURE REACTION. (Illustrated.) By Harris J. Ryan and Milton E. Thompson. No. 3, March. RESONANCE IN ALTERNATING CURRENT LINES. (Illustrated.) By E. J. Houston and A. E. Kennelly. UNDERWRITERS' RULES. By W. A. Anthony. No. 4, April. OBITUARY.—George M. Phelps. LEONARD ON EUROPEAN ENGINEERING. (Chicago Discussion.) RYAN AND THOMPSON ON ARMATURE REACTION. (Chicago Discussion.) HOUSTON AND KENNELLY ON RESONANCE. (New York Discussion.) ANTHONY ON UNDERWRITERS RULES. New York and Chicago Discussion. PRELIMINARY REPORT INDEXING COMMITTEE. REPORT OF COUNCIL, SECRETARY, TREASURER AND TELLERS. No. 5, May.

American Institute of Electrical Engineers.

Members of the Institute, who have been transferred from associate to full membership, can now receive the official Certificate issued by the Institute, upon applying to the Secretary, and enclosing the sum of two dollars ($2.00) to cover cost of same, and the engrossing of names, necessary dates, etc. In ordering a certificate, the name of the applicant should be plainly written, exactly as he desires to have it appear. These Certificates are printed upon heavy parchment paper, from an engraved steel plate.

Associate as well as Full Members are entitled to receive the Official Badge of the Institute, which is now prepared in the following forms and at prices stated: Pin, $3; Scarf-pin, $3; Lapel Button, $3; Watch Charm, $3; Locket for single picture, $8; Double Locket for two pictures, $10.

THE OFFICIAL BADGE ADOPTED BY THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS EMBODIES THE FOLLOWING CHARACTERISTICS

FRANKLIN'S KITE, which demonstrated the identity between **Lightning** and **Electricity,** and represents **static electricity.** It is a recognition of **America's first Electrician** and **Philosopher, Benjamin Franklin.**

A diagrammatic representation of **Wheatstone's Bridge,** one of the most important pieces of electrical testing apparatus

THE GALVANOMETER, another equally important piece of testing apparatus and which represents **Magnetism** and **Induction.**

THE AMBER of which the galvanometer is made represents the **first conception of electricity,** dating back to 600 years B. C., when Thales, the Greek philosopher, recorded the fact that amber, when rubbed, attracted light particles to it, and the Greeks worshipped it, believing the gods had endowed it with life, and that it possessed a soul.

In 1600 A. D., Dr. Gilbert, court physician to Queen Elizabeth, coined the word **Electricity** from the word **Elektron,** the Greek name for Amber.

A. I. E. E. represents the initials of the American Institute of Electrical Engineers.

$C=\frac{E}{R}$ represents represents Ohm's Law—a fundamental law in electrical work.

The badge is made of white enamel, with the lettering and front portions of 18 karat gold, and the backing in 14 karat gold. **Apply to the Secretary, 26 Cortlandt St., New York.**

Information Regarding Transactions.

The monthly parts distributed to members and subscribers during the year, are not intended for binding, but simply for the use of readers, as the work of the Institute progresses.

After printing the monthly, the papers and discussions are revised, repaged, and the sheets for the annual volume printed from the corrected type, and laid aside till the close of the year. As the index is made for the volume and **not** for the monthly parts, the complete volume sent at the end of the year becomes the permanent record. Upon its receipt the monthly parts are superfluous. They may be returned to this office at our expense, as there is a continual demand for separate copies of papers.

RALPH W. POPE, Secretary.